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(12) **United States Patent**
Kanehisa et al.

(10) **Patent No.: US 6,309,028 B1**
(45) **Date of Patent: Oct. 30, 2001**

(54) **BICYCLE HUB**

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(73) Assignee: **Shimano Inc.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/528,191**

(22) Filed: **Mar. 17, 2000**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/494,544, filed on Jan. 31, 2000.

(51) **Int. Cl.**[7] **B60B 1/04**; B60B 27/00
(52) **U.S. Cl.** **301/110.5**; 301/59
(58) **Field of Search** 301/58, 59, 61, 301/110.5, 110.6

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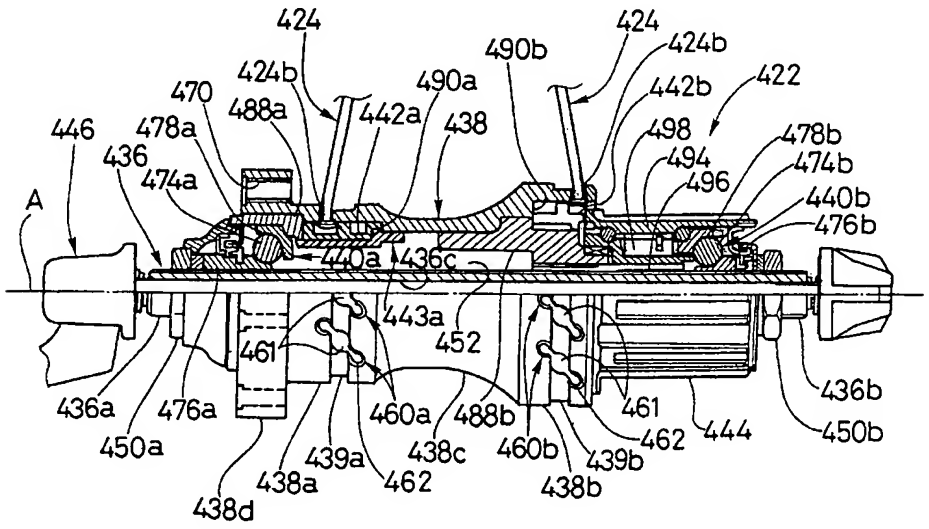
Primary Examiner—Russell D. Stormer
(74) *Attorney, Agent, or Firm*—Shinjyu Global IP Counselors, LLP

(57) **ABSTRACT**

A bicycle hub is provided with spoke openings that extend into the interior of the hub. The bicycle hub basically has a hub axle, a hub body and seals arranged in the hub body. The hub axle has a center axis extending between a first end and a second end. The hub body has an interior passageway with the hub axle being rotatably supported therein. The hub body also has first and second spoke openings circumferentially arranged around the ends of the hub body. A first seal is arranged in the interior passageway of the hub body and adjacent the first spoke openings to isolate the first spoke openings from the hub axle. A seal support is located beneath the first seal to prevent radial inward movement of the first seal. A second seal is arranged in the interior passageway of the hub body and adjacent the second spoke openings to isolate the second spoke openings from the hub axle. Preferably, the spoke opening covers are located in grooves of the hub body to seal the insertion portions of the first and second spoke openings.

24 Claims, 19 Drawing Sheets



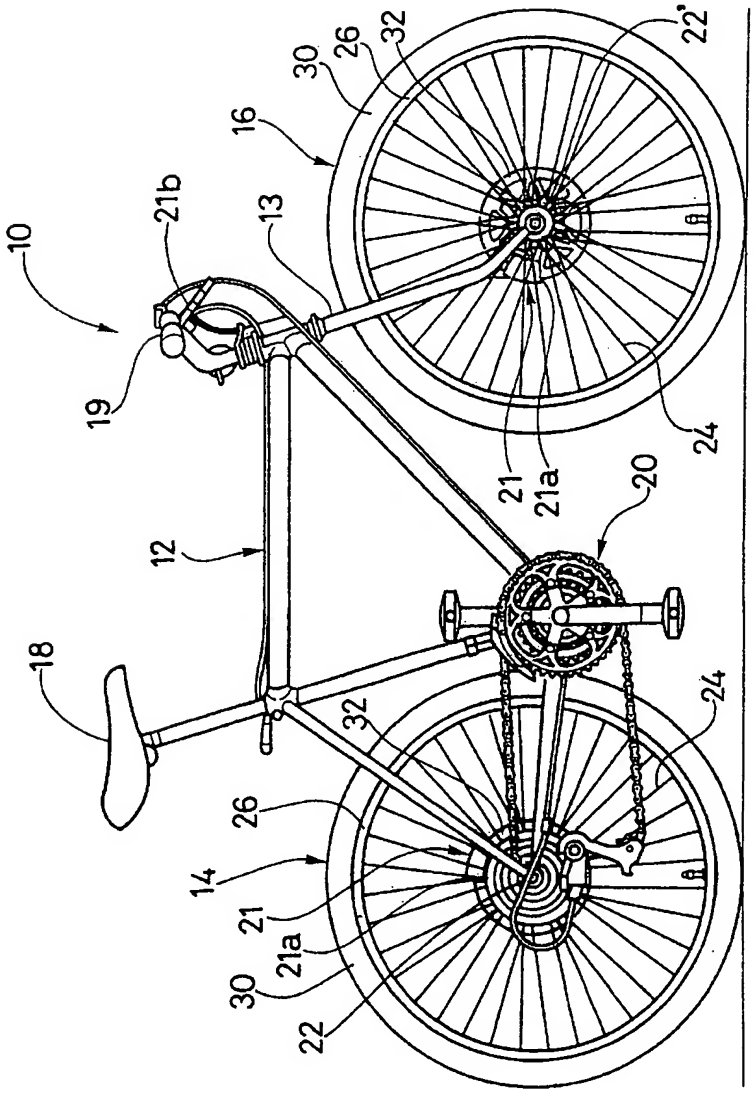


FIG. 1

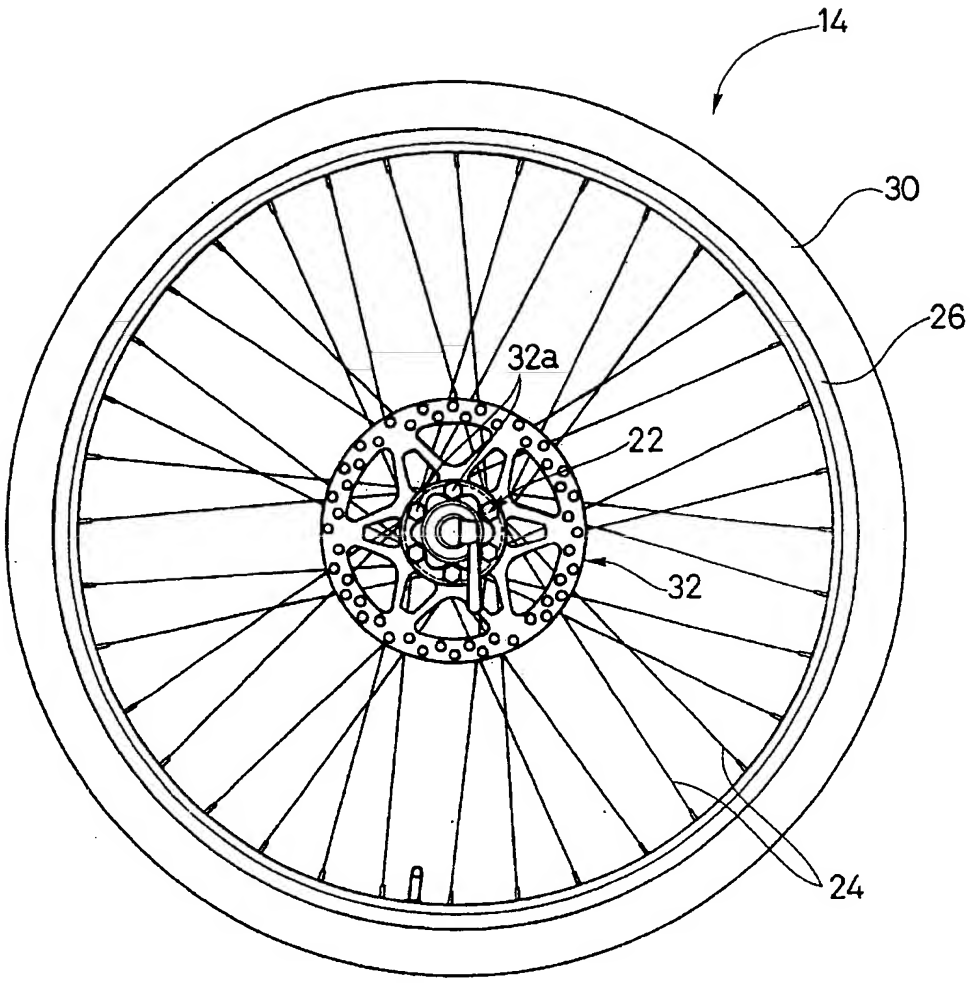


FIG. 2

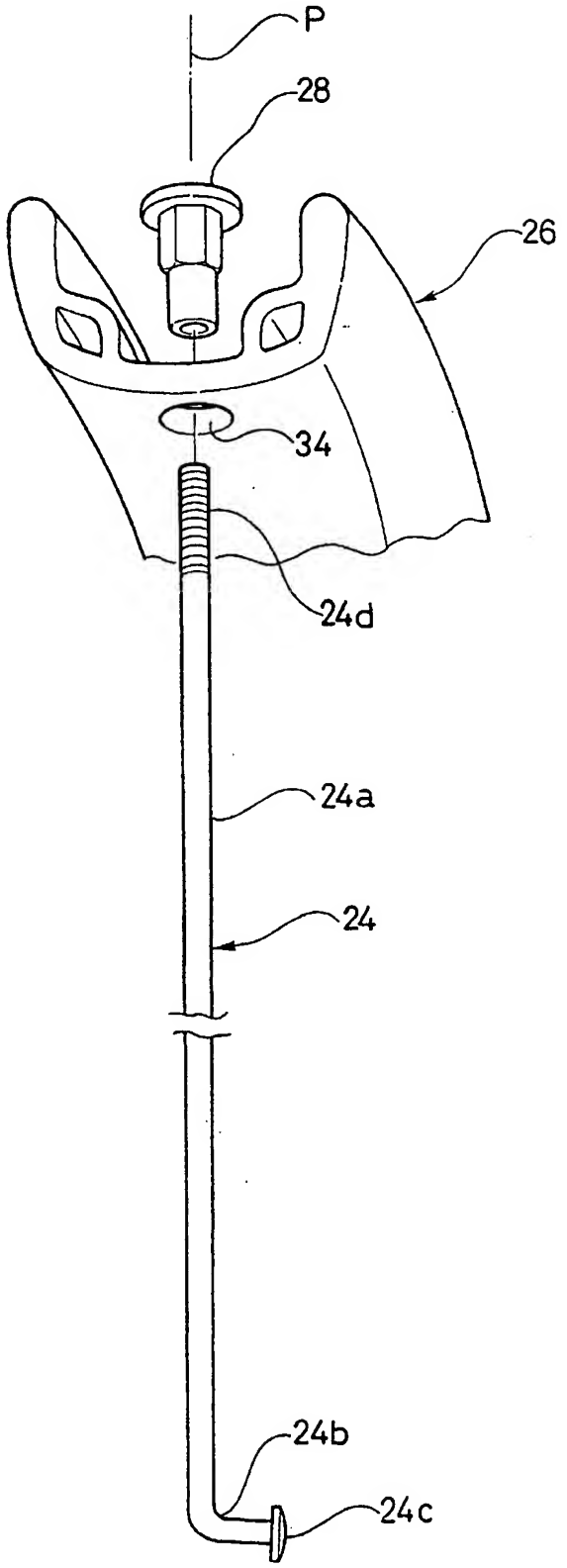


FIG. 3

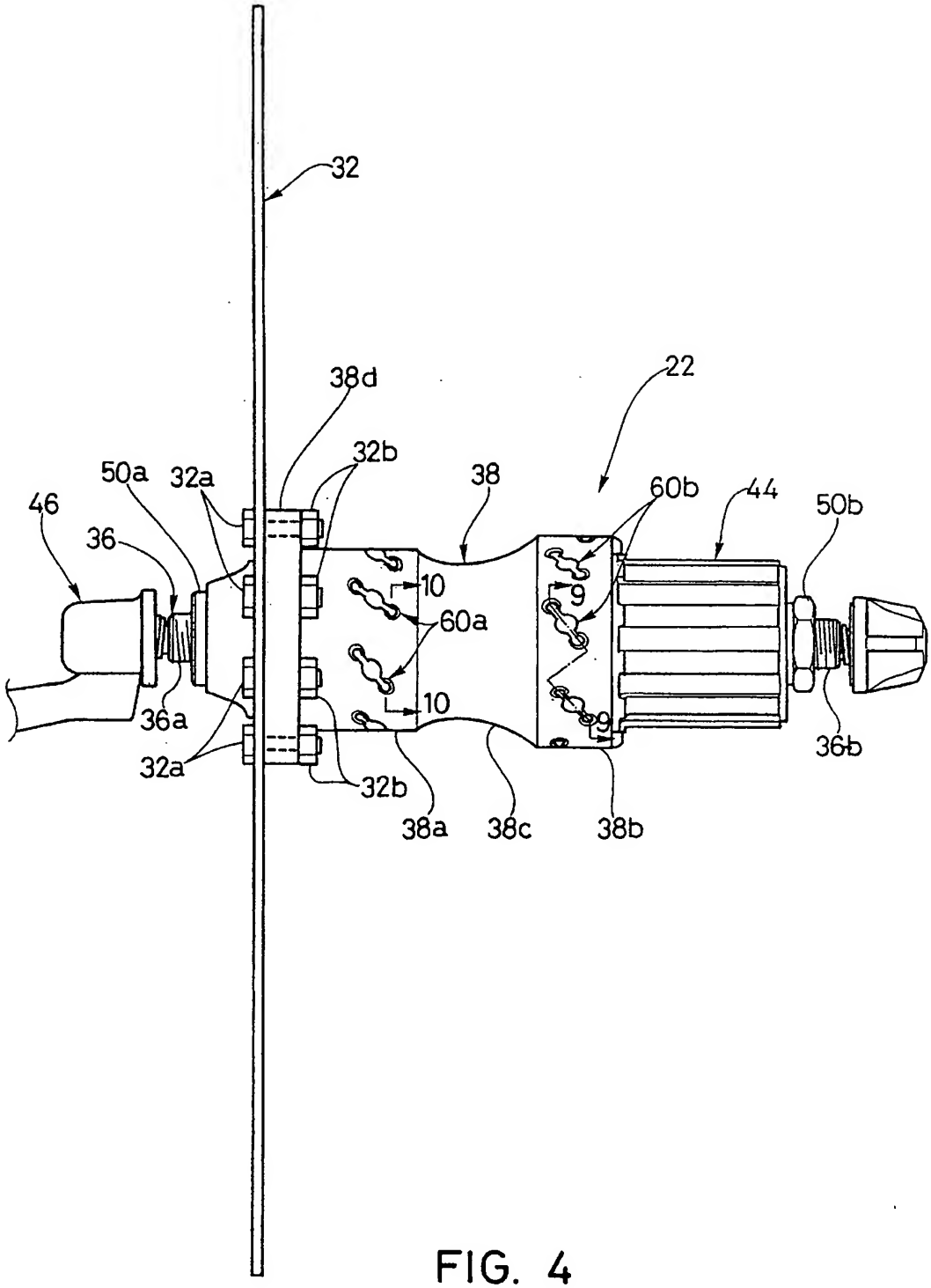
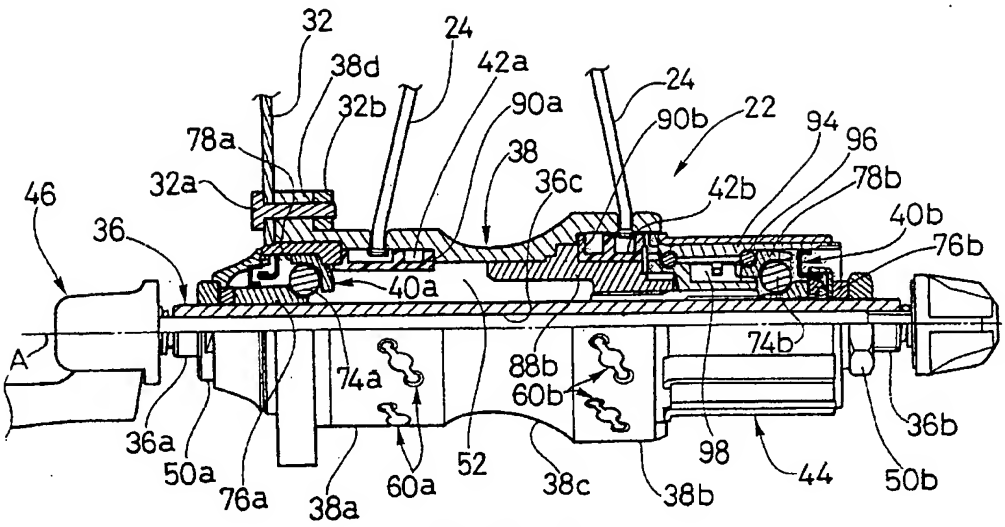

32
38d
22
32b
50a
32a
38
60b
44
50b
46
36
10
9
60a
10
9
36a
32a
32b
36b
38a
38c
38b

FIG. 4



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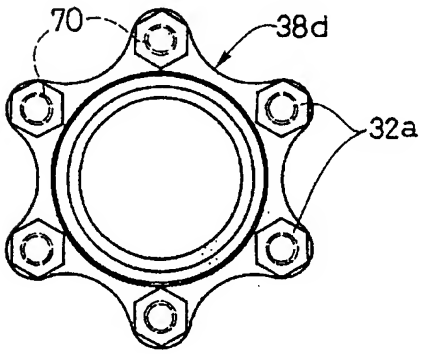

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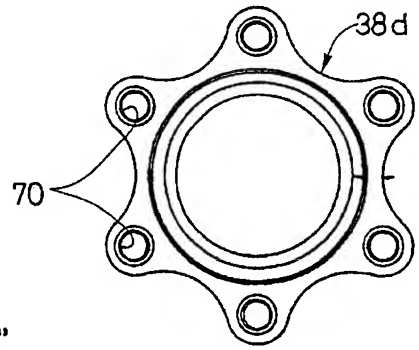

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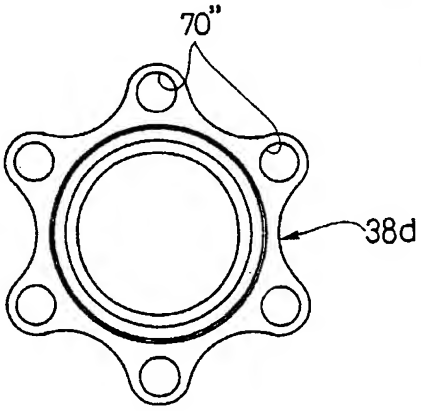
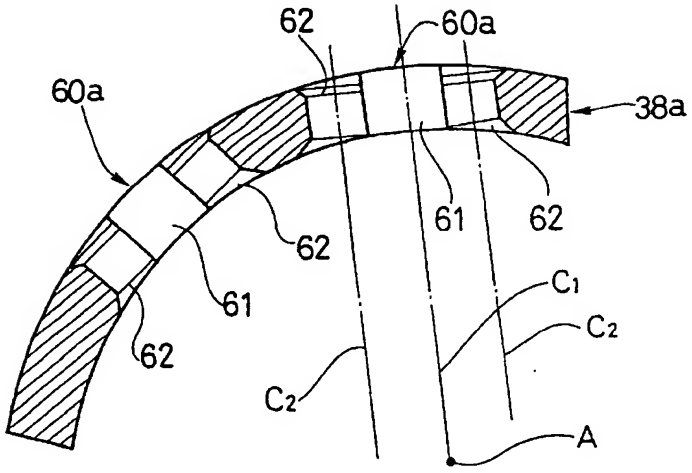


FIG. 8

FIG. 9



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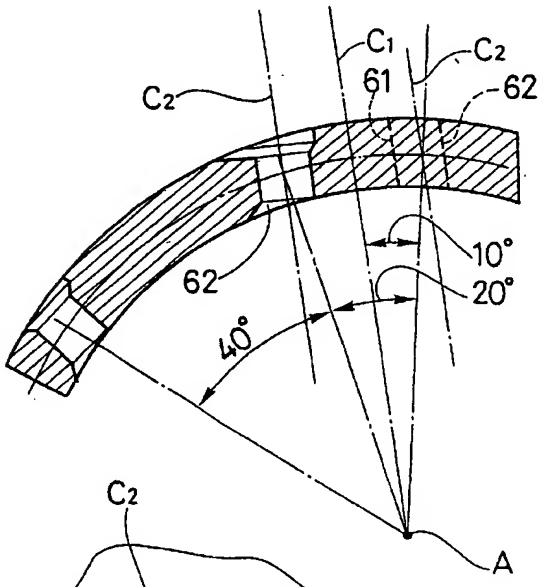

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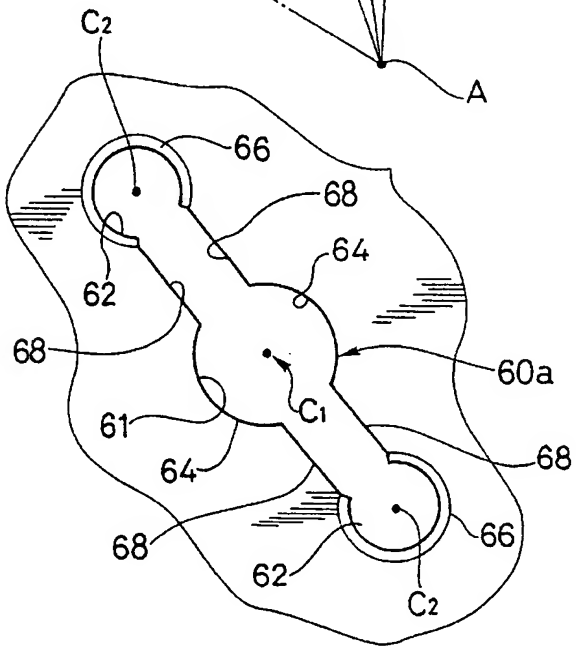


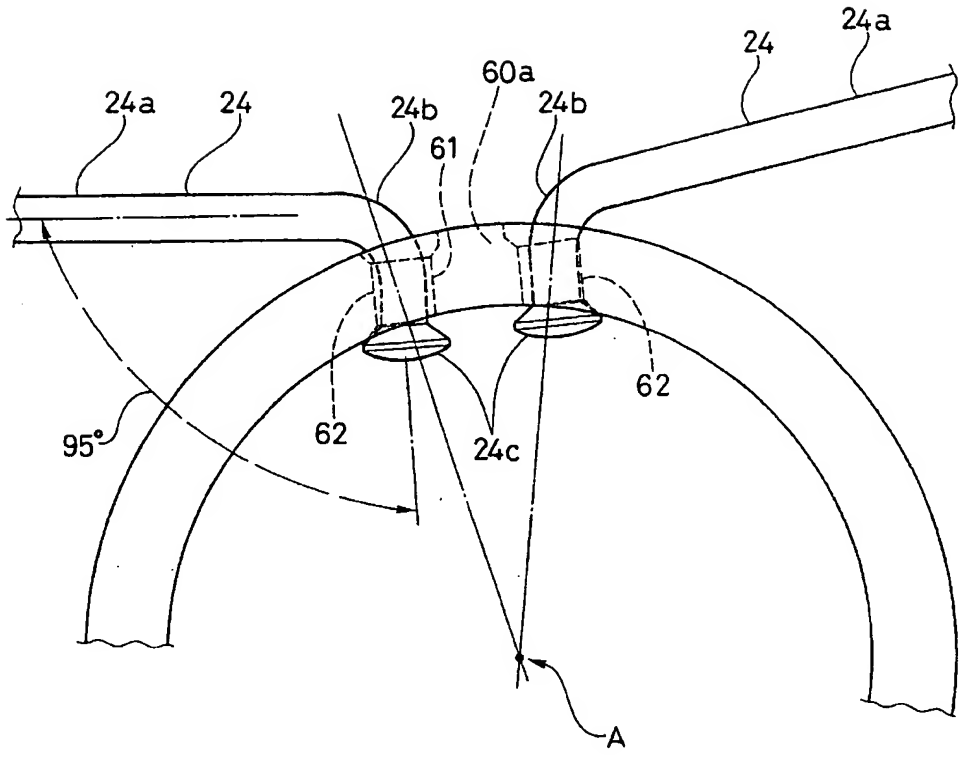


FIG. 12

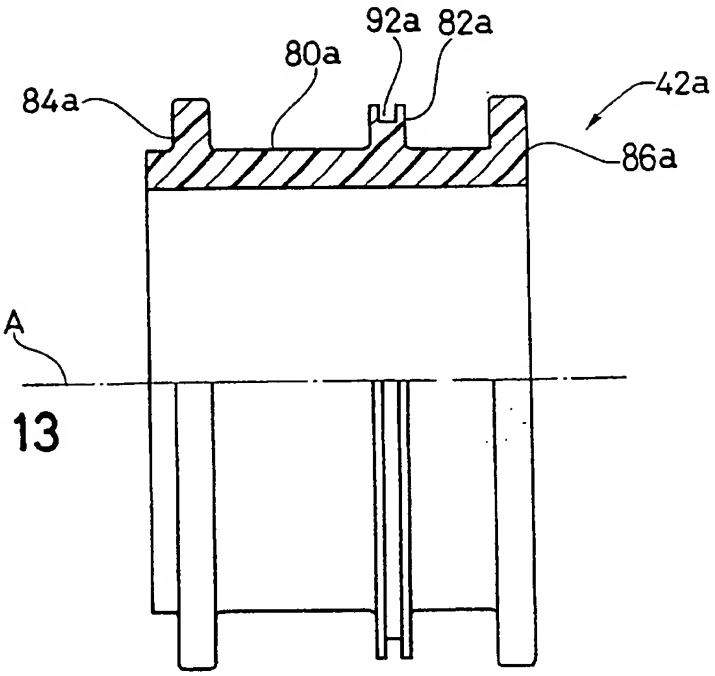
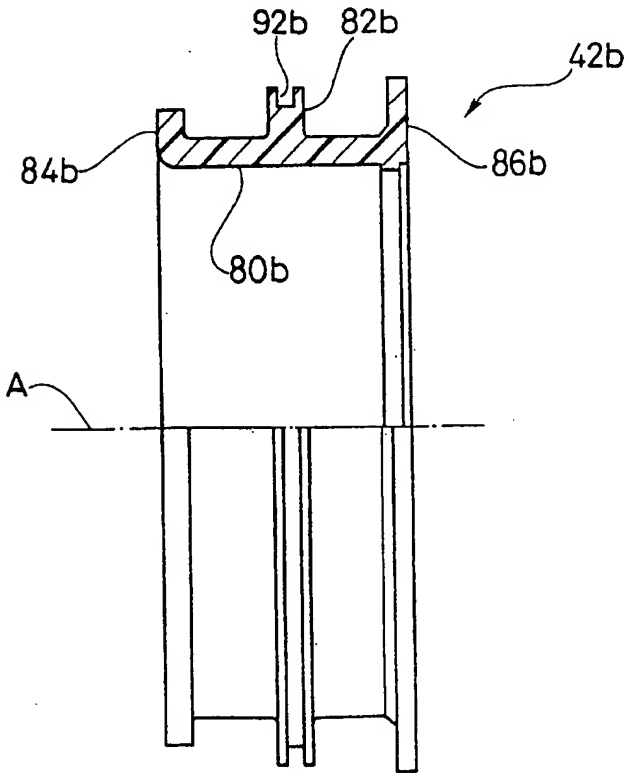


FIG. 13



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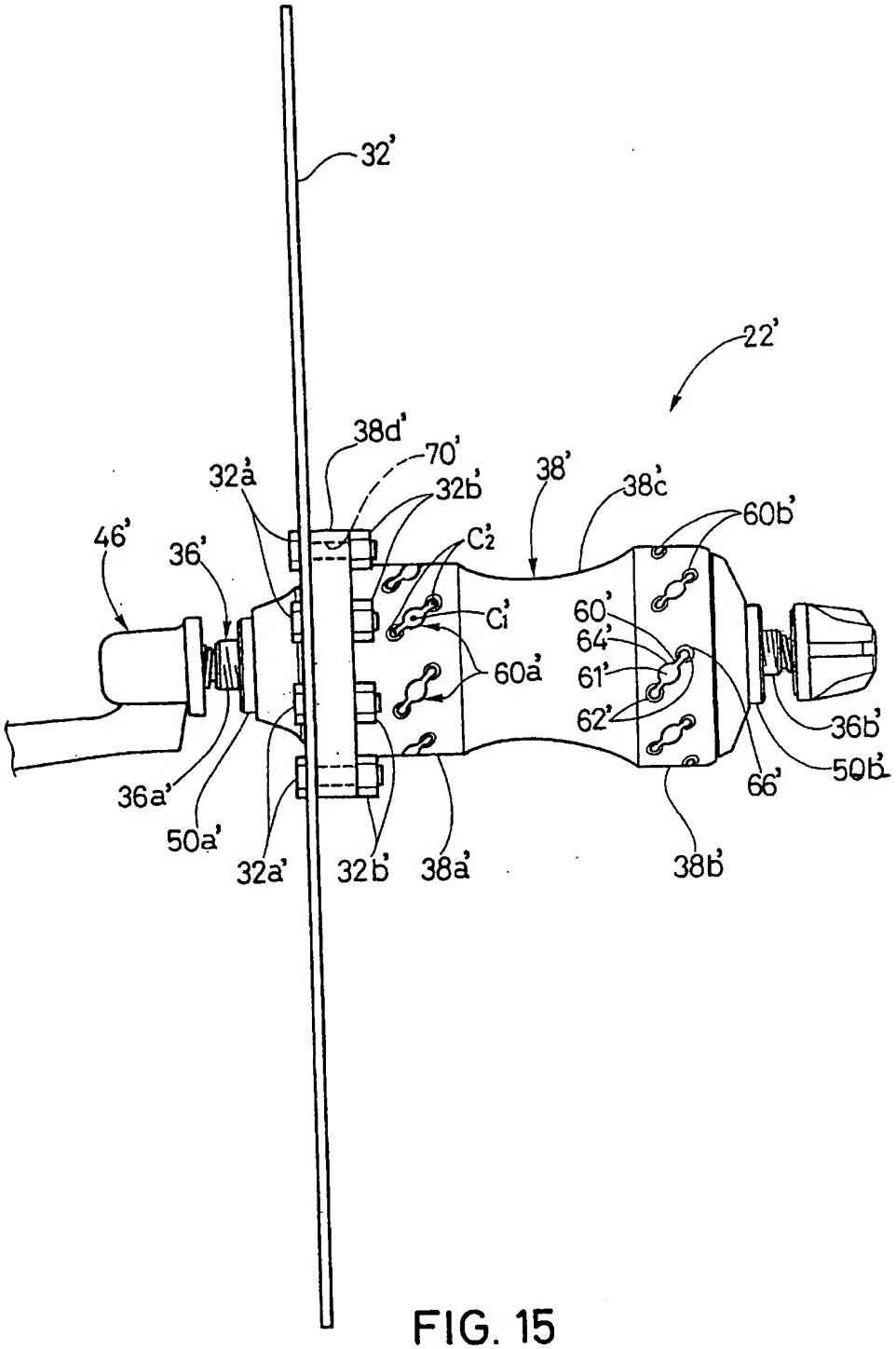

32'
22'
38d'
70'
32a'
32b'
38'
38c'
60b'
46'
36'
C2'
C1'
60'
64'
61'
62'
60a'
36b'
50b'
66'
36a'
50a'
32a'
32b'
38a'
38b'

FIG. 15

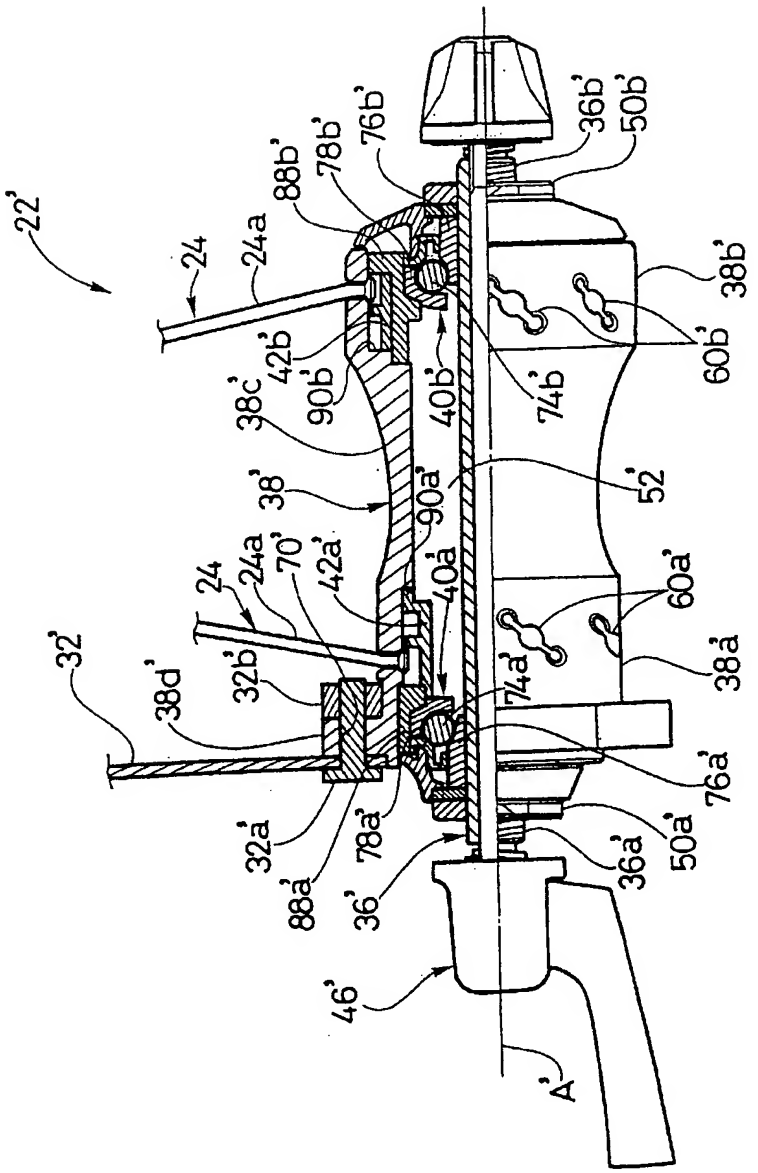
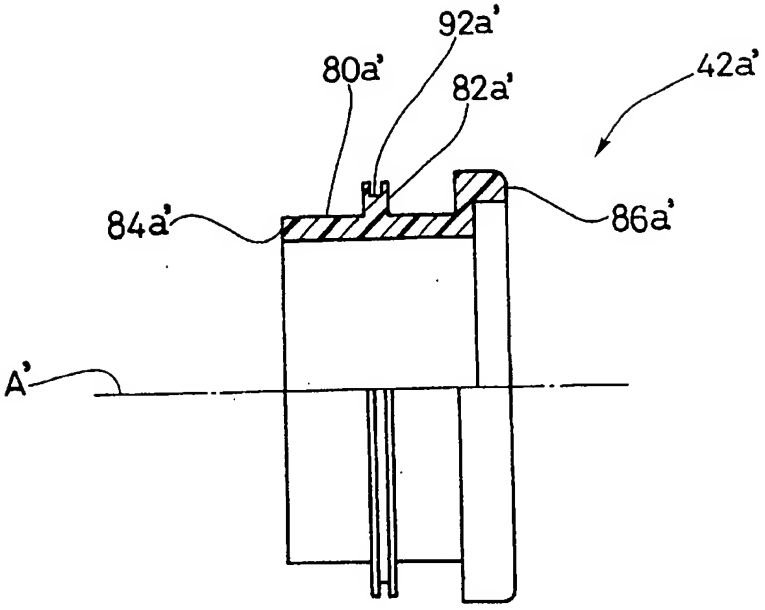

22'
24
24a
88b'
78b'
76b'
36b'
50b'
38b'
60b'
74b'
40b'
90b'
42b'
38c'
38'
90a'
52'
70'
42a'
40a'
60a'
74a'
38a'
32'
38d'
32b'
32a'
88a'
78a'
36'
76a'
50a'
36a'
46'
A'

FIG. 16



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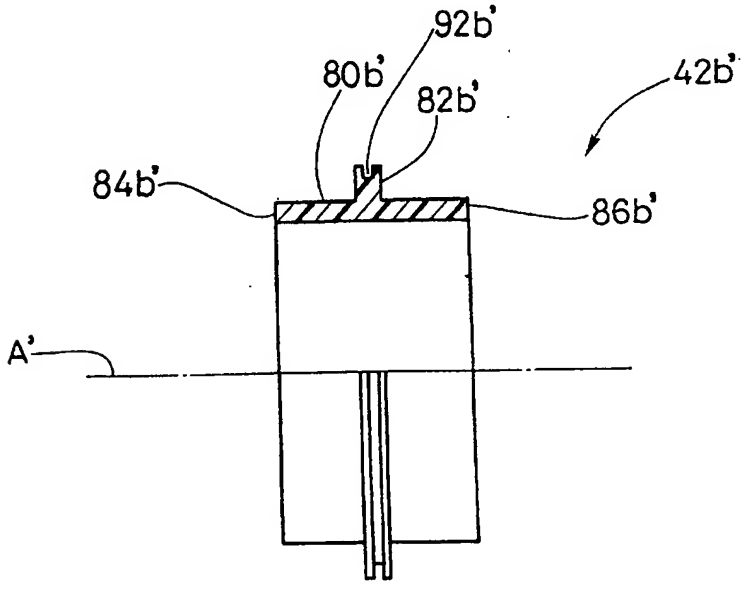

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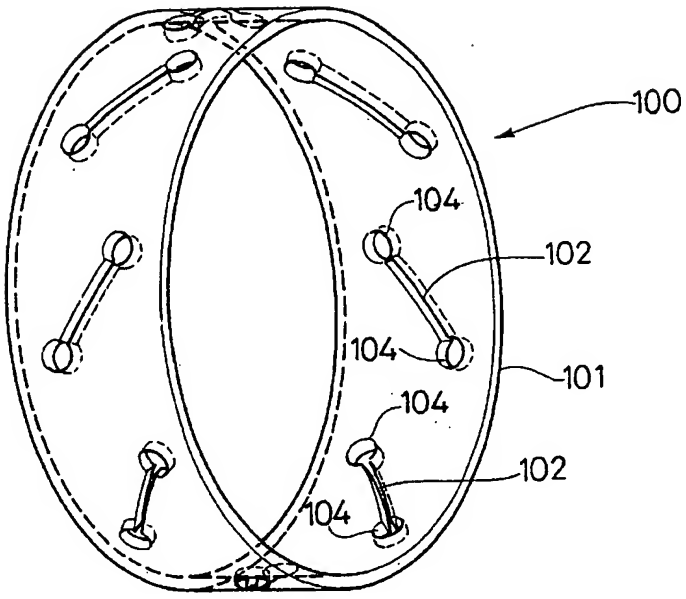

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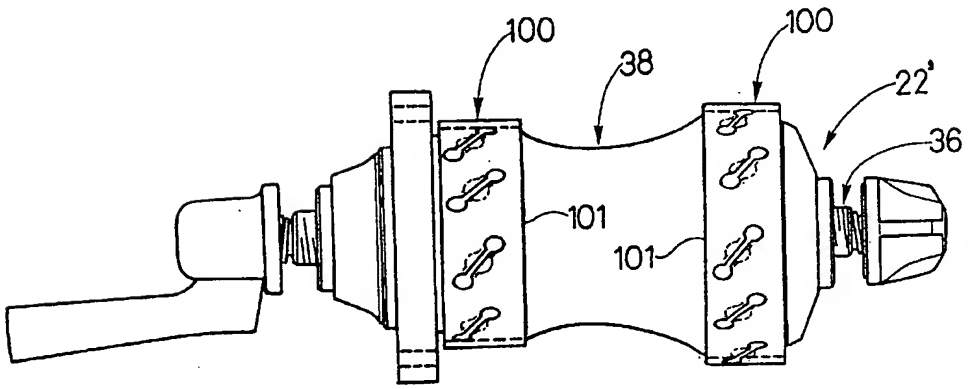

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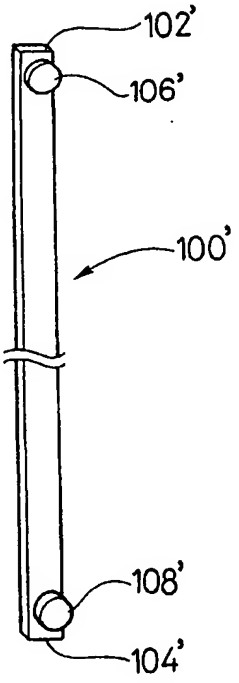

102'
106'
100'
108'
104'

FIG. 21

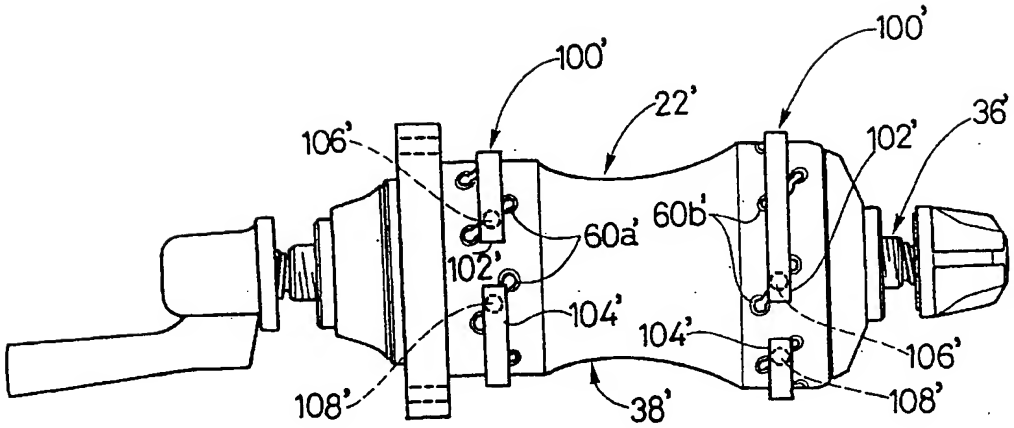

100'
100'
22'
106'
102'
36'
60b'
60a'
102'
104'
104'
106'
108'
38'
108'

FIG. 22

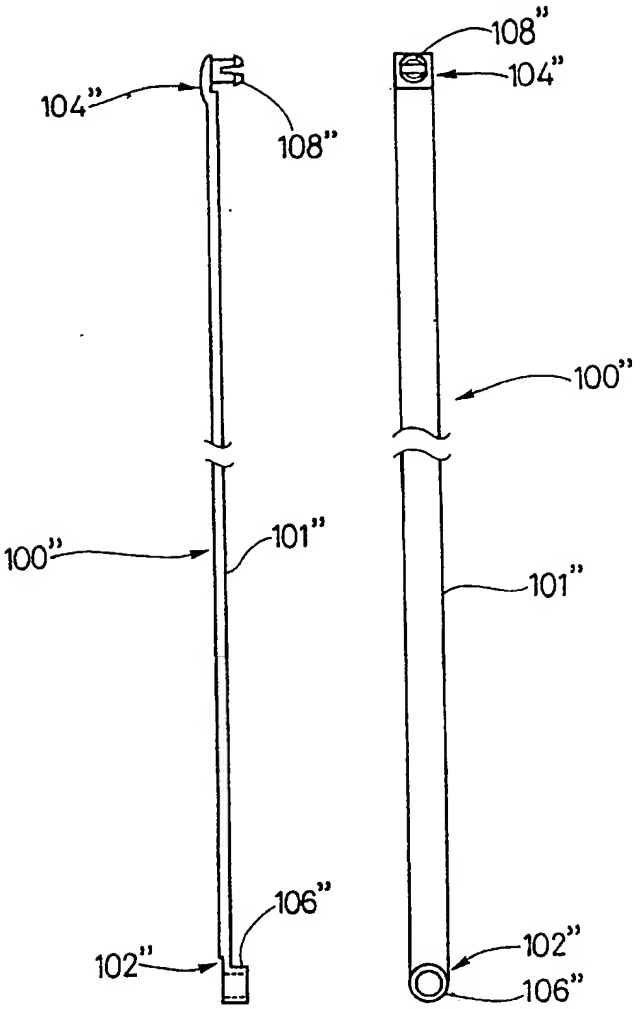


FIG. 23 FIG. 24

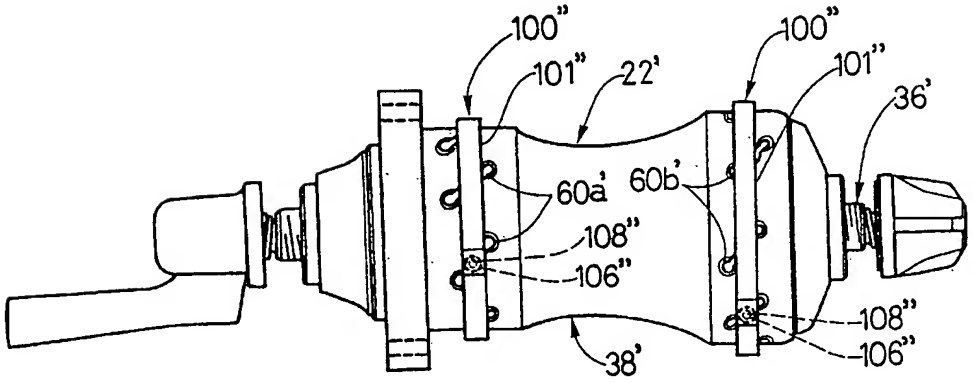


FIG. 25

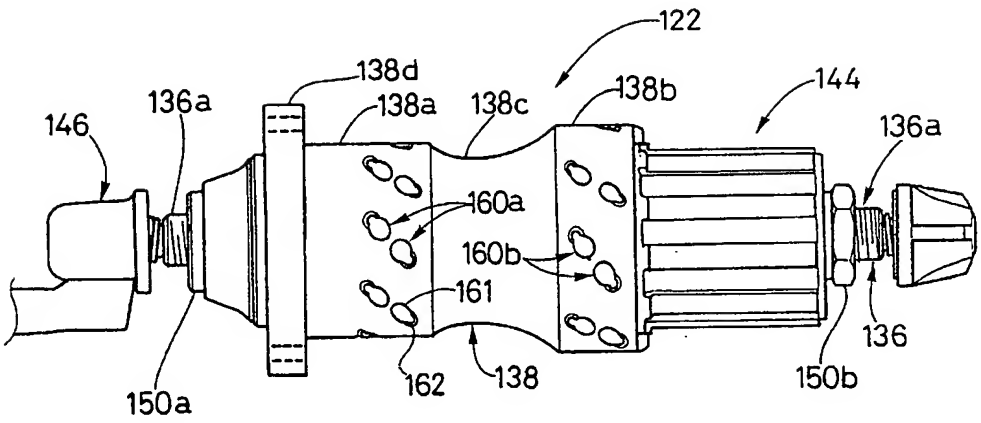

122
138d
136a
138a
138c
138b
144
146
136a
160a
160b
161
136
162
138
150b
150a

FIG. 26

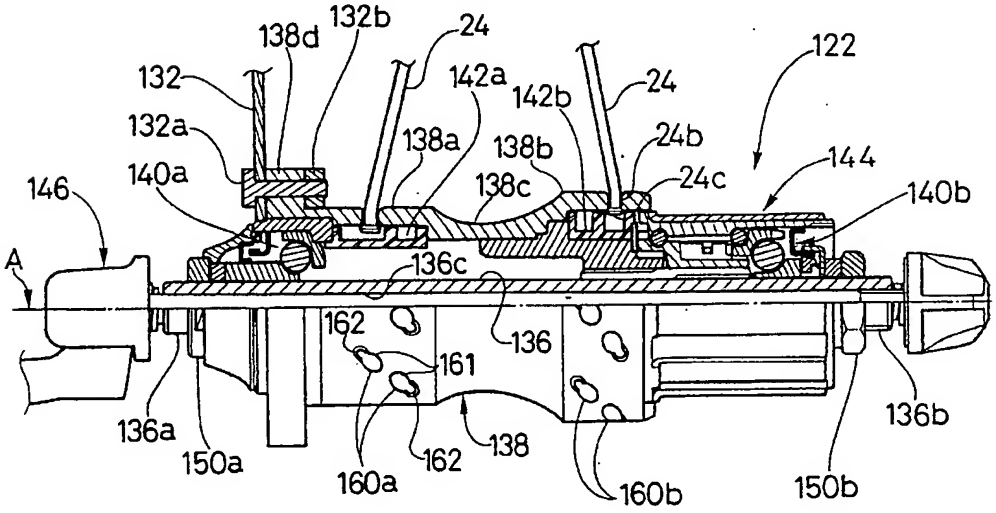

138d
132b
24
122
132
142a
142b
24
132a
138a
138b
24b
144
140a
138c
24c
146
140b
A
136c
162
136
161
136b
136a
150a
138
160a
162
160b
150b

FIG. 27

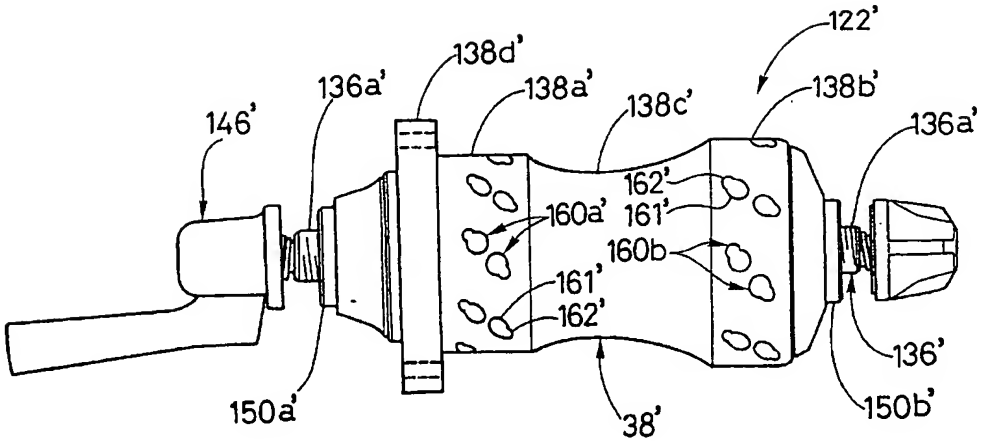

122'
138d'
136a'
138a'
138c'
138b'
146'
136a'
162'
160a'
161'
160b
161'
162'
136'
150a'
38'
150b'

FIG. 28

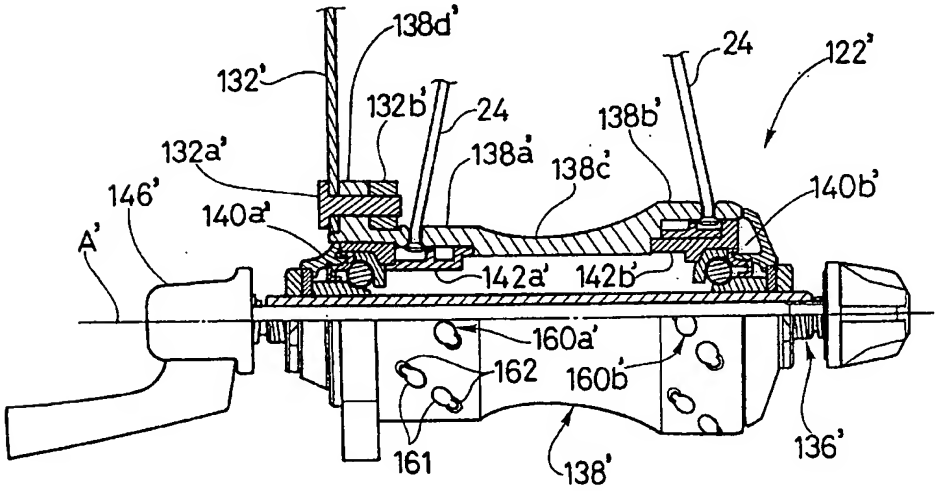
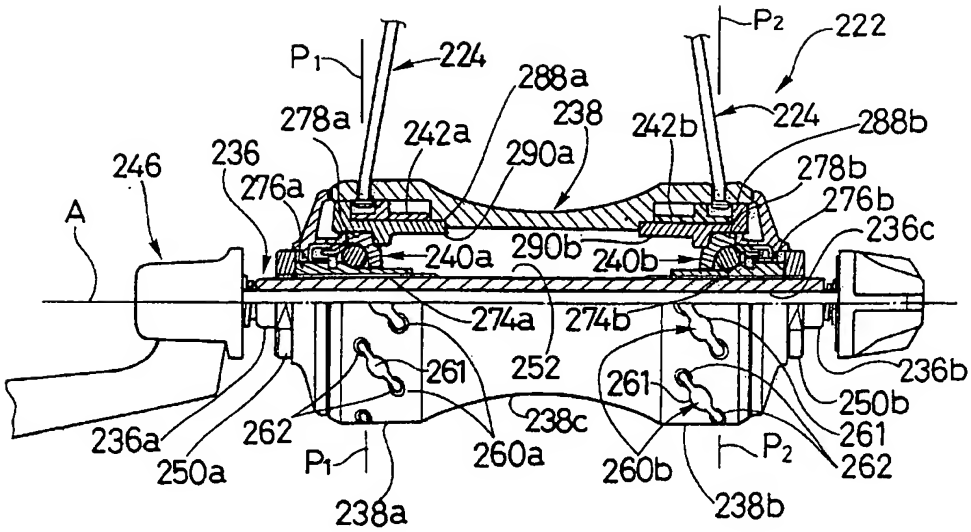

138d'
24
122'
132'
132b'
24
138b'
132a'
138a'
138c'
140b'
146'
140a'
A'
142a'
142b'
160a'
162
160b'
161
138'
136'

FIG. 29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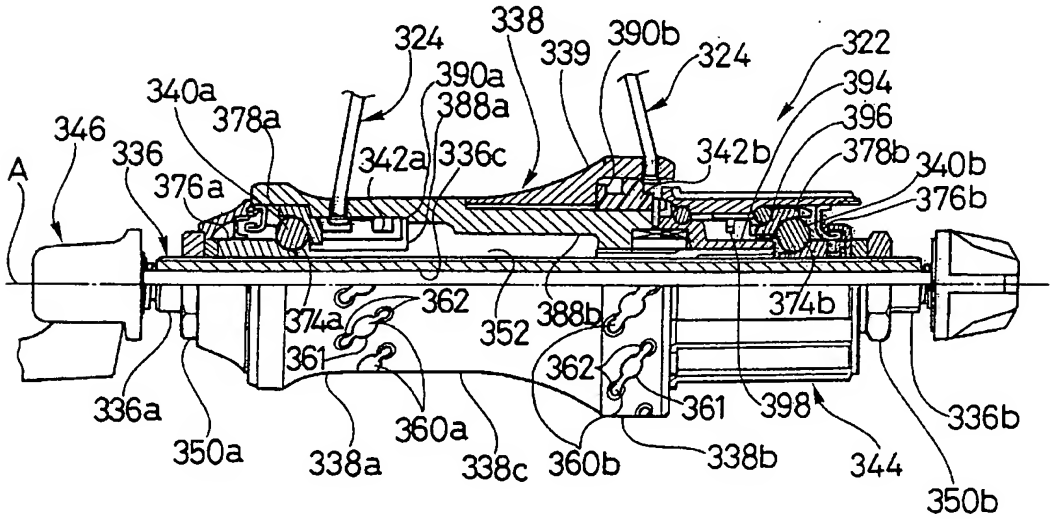
278a
242a
238
242b
P2
222
224
288b
246
236
276a
290a
278b
276b
A
240a
290b
240b
236c
274a
274b
252
261
261
236b
250b
236a
262
238c
261
250a
P1
260a
260b
P2
262
238a
238b

FIG. 30


324
338
339
390b
324
322
340a
390a
394
346
378a
388a
396
336
342a
336c
342b
378b
340b
A
376a
376b
374a
362
352
388b
374b
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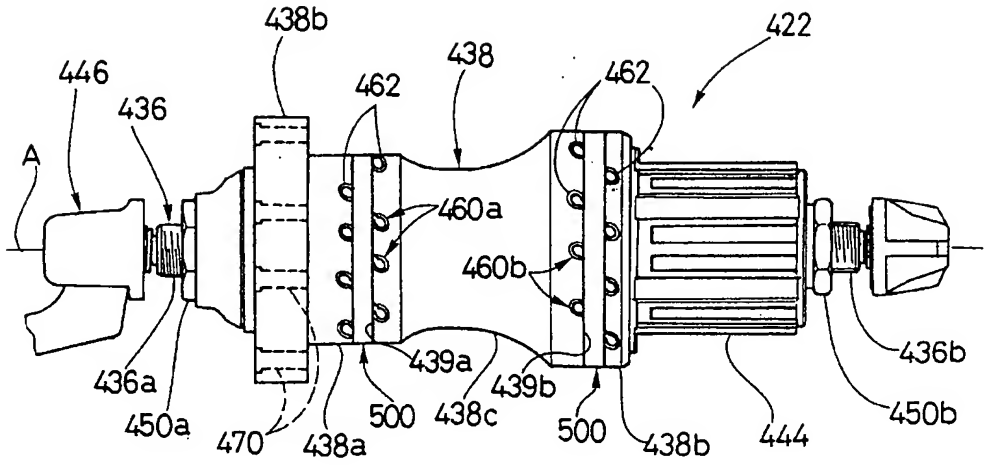
336b
350a
360a
360b
338b
344
338a
338c
350b

FIG. 31


438b
422
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438
462
462
436
A
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460b
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436a
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450a
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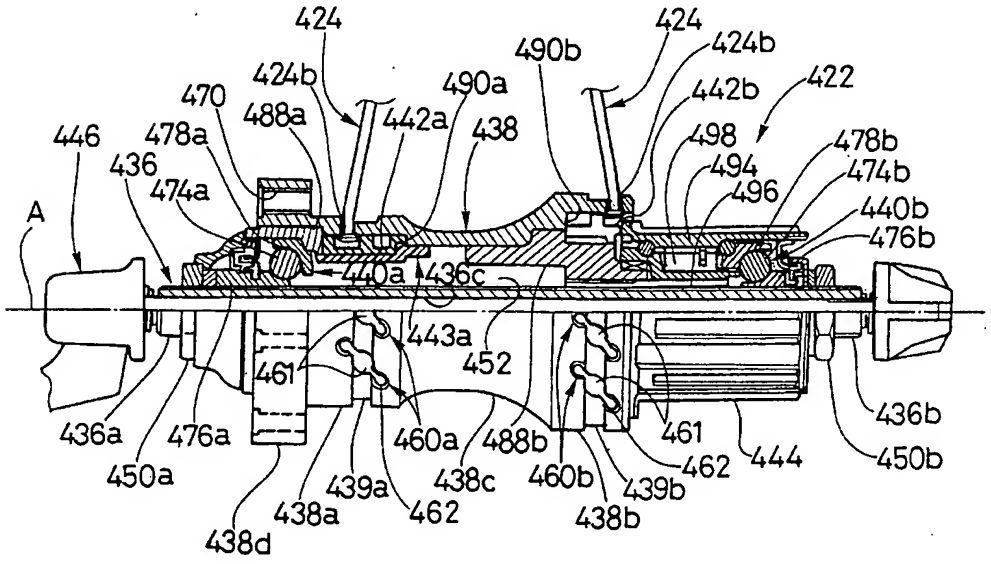
438c
500
470
438a
438b
444

FIG. 32


424
424
490b
424b
424b
422
470
490a
442b
488a
442a
438
498
446
478a
478b
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494
474b
474a
496
A
440b
476b
440a
436c
443a
452
461
436b
436a
476a
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450a
439a
438c
460b
439b
438a
462
438b
438d

FIG. 33

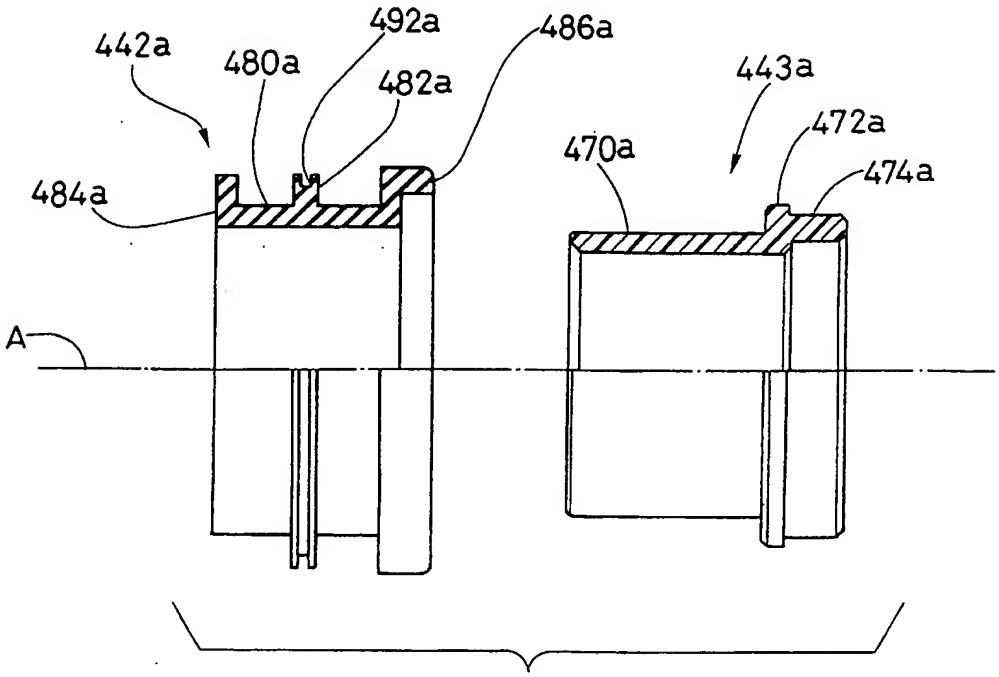

FIG. 34

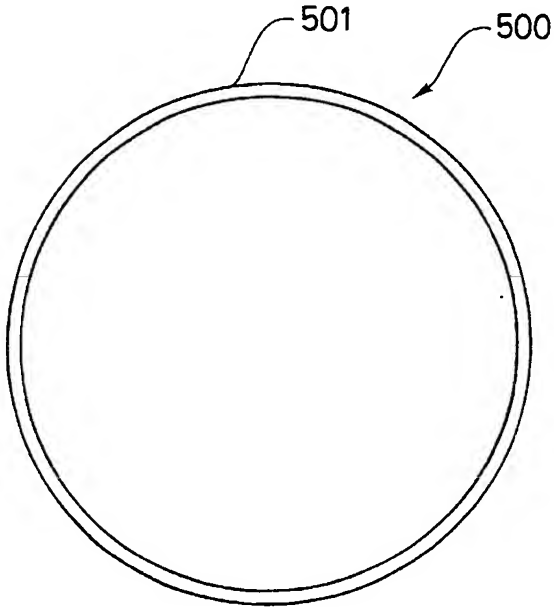

FIG. 35

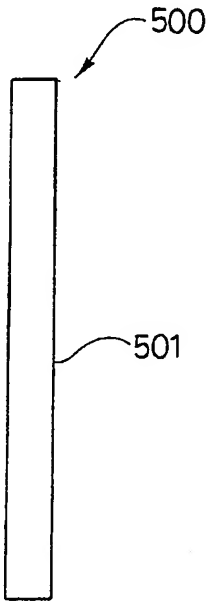

FIG. 36

BICYCLE HUB

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part application of U.S. patent application Ser. No. 09/494,544, filed on Jan. 31, 2000. The entire disclosure of U.S. patent application Ser. No. 09/494,544 is hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention generally relates to a bicycle hub with spoke openings in the tubular portion of the hub body. More specifically, the present invention relates to a bicycle hub with a seal that isolates the spoke openings from the remainder of the interior of the hub body.

2. Background Information

Bicycling is becoming an increasingly popular form of recreation as well as a means of transportation. Moreover, bicycling has become a very popular competitive sport. Whether the bicycle is used for recreation, transportation or competition, the bicycle industry is constantly improving their components. Recently, the braking systems for bicycles have included the use of disc brakes. The use of disc brakes has resulted in modifications to the bicycle hub of the bicycle wheel so that a brake rotor can be mounted thereon.

The most basic bicycle wheels have a hub, a plurality of spokes and an annular rim. The hub is attached to a part of the frame of the bicycle for relative rotation. The inner ends of the spokes are coupled to the hub and extend outwardly from the hub. The annular rim is coupled to the outer ends of the spokes and has an outer portion for supporting a pneumatic tire thereon. Typically, the spokes of the bicycle wheel are thin metal wire spokes. The ends of the hub are provided with a flange that is used to couple the spokes to the hub. In particular, holes are provided in the hub flanges. The wire spokes are usually bent on their inner end and provided with an enlarged head or flange that is formed in the shape of a nail head. The inner end is supported in one of the holes in one of the hub flanges. The outer ends of the spokes typically are provided with threads for engaging spoke nipples, which secure the outer ends of the wire spokes to the rim. In particular, the spoke nipples have flanges, which engage the interior surface of the rim.

With a spoke constructed in this manner, the nipples are installed in nipple holes formed in the rim. The spokes are inserted sideways through the holes in the hub flange until the enlarged head or flanges of the spokes engaging the areas surrounding the holes in the hub flange. The male threads on the ends of the spokes are threaded into the female threads of the spoke nipples installed in the openings of the rim.

When the hub is a brake disc hub or is a rear hub, installation and/or replacement of the spokes can be difficult. In the case of a disk brake hub, one end of the hub usually has a rotor mounting portion. Often, the rotor mounting portion is a plurality of blind bores that receive bolts to directly mount the brake disc rotor to the end of the hub. Thus, the brake disc rotor makes it difficult to insert the spokes in a sideways direction. Likewise, if the hub is a rear hub, the sprockets can be obstacles to install or replace spokes.

One problem with spoke openings in the tubular portion of the hub body is that contaminants can enter the hub body through the spoke openings. When dirt gets into the hub body, the rotation of the hub body relative to the hub axle can be significantly impair.

In view of the above, there exists a need for a bicycle hub with a spoke seal which overcomes the above mentioned problems in the prior art. This invention addresses this need in the prior art as well as other needs, which will become apparent to those skilled in the art from this disclosure.

SUMMARY OF THE INVENTION

One object of the present invention is to provide a bicycle hub having a seal with a seal support for isolating the spoke openings form the interior of the hub body.

Another object of the present invention is to provide a bicycle hub having a seal with a seal support that aids in the installation of the spokes.

Another object of the present invention is to provide a bicycle hub that has first spoke openings with an insertion portion and a retaining portion, and a spoke opening cover located along a first annular groove intersecting the insertion portions.

Another object of the present invention is to provide a bicycle hub that is relatively lightweight in that no spoke flanges are needed.

The foregoing objects can be attained by providing a bicycle hub for use with bicycle spokes. The bicycle hub comprising a hub axle, a hub body, a first flexible seal arranged in the hub body and a first rigid seal support. The hub axle has a center axis extending between a first end and a second end. The hub body has an interior passageway with the hub axle being rotatably supported therein. The hub body has a set of first spoke openings circumferentially arranged around the hub body. The first flexible seal is arranged in the interior passageway of the hub body and adjacent the first spoke openings to isolate the first spoke openings from the hub axle. The first rigid seal support is located beneath the first flexible seal to radially support the first flexible seal.

The foregoing objects can further be attained by providing a bicycle hub for use with bicycle spokes. The bicycle hub comprising a hub axle and a hub body. The hub axle has a center axis extending between a first end and a second end. The hub body has an outer surface with a first annular groove, an interior passageway with the hub axle being rotatably supported therein and a set of first spoke openings circumferentially arranged around the hub body. Each of the first spoke openings has an insertion portion located along the first annular groove and a retaining portion. The insertion portion has a large width that permits an enlarged head portion of a spoke to pass therethrough. The retaining portion has a width that is smaller than the width of the insertion portion to retain the enlarged head portion of the spoke therein.

These and other objects, features, aspects and advantages of the present invention will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses a preferred embodiment of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the attached drawings which form a part of this original disclosure:

FIG. 1 is a side elevational view of a conventional bicycle with front and rear brake disc hubs in accordance with a first embodiment of the present invention;

FIG. 2 is a side elevational view of the rear wheel of the bicycle illustrated in FIG. 1 with the sprockets removed;

FIG. 3 is partially exploded perspective view of the rim, one of the spokes and one of the spoke nipples of the bicycle illustrated in FIG. 1;

FIG. 4 is a side elevational view of the rear brake disc hub of the rear wheel illustrated in FIG. 2 with the sprockets removed;

FIG. 5 is a side elevational view of the rear brake disc hub of the rear wheel illustrated in FIG. 3 with certain portions broken away for purposes of illustration;

FIG. 6 is a left end elevational view of the rear brake disc hub body illustrated in FIGS. 4 and 5 with the brake disc rotor bolts mounted thereto;

FIG. 7 is a left end elevational view of the rear brake disc hub body illustrated in FIGS. 4 and 5 with the brake disc rotor bolts removed;

FIG. 8 is a left end elevational view of the rear brake disc hub body illustrated in FIGS. 4 and 5 with unthreaded bolt holes;

FIG. 9 is a partial transverse cross-sectional view of the rear brake disc hub body illustrated in FIGS. 4 and 5 as seen along section line 9—9 of FIG. 4;

FIG. 10 is a partial transverse cross-sectional view of the rear brake disc hub body illustrated in FIGS. 4 and 5 as seen along section line 10—10 of FIG. 4;

FIG. 11 is a partial elevational view of one of the spoke openings of the rear brake disc hub body illustrated in FIGS. 4 and 5;

FIG. 12 is a schematic view of portion of the rear brake disc hub body illustrated in FIGS. 4 and 5 with two spokes extending outwardly therefrom;

FIG. 13 is a partial cross-sectional view of the first seal for the rear brake disc hub body illustrated in FIGS. 4 and 5;

FIG. 14 is a partial cross-sectional view of the second seal for the rear brake disc hub body illustrated in FIGS. 4 and 5;

FIG. 15 is a side elevational view of the front brake disc hub of the front wheel illustrated in FIG. 1;

FIG. 16 is a side elevational view of the front brake disc hub of the front wheel illustrated in FIG. 1 with certain portions broken away for purposes of illustration;

FIG. 17 is a partial cross-sectional view of the first seal for the front brake disc hub body illustrated in FIGS. 15 and 16;

FIG. 18 is a partial cross-sectional view of the second seal for the front brake disc hub body illustrated in FIGS. 15 and 16;

FIG. 19 is a perspective view of a first embodiment of a spoke opening cover for the hubs of the present invention;

FIG. 20 is a side elevational view of the front brake disc hub with the spoke opening cover illustrated in FIG. 19 installed thereon;

FIG. 21 is a perspective view of a second embodiment of a spoke opening cover for the hubs of the present invention;

FIG. 22 is a side elevational view of the front brake disc hub with the spoke opening cover illustrated in FIG. 21 installed thereon;

FIG. 23 is an inside elevational view of a third embodiment of a spoke opening cover for the hubs of the present invention;

FIG. 24 is an edge elevational view of the spoke opening cover illustrated in FIG. 23 for the hubs of the present invention;

FIG. 25 is a side elevational view of the front brake disc hub with the spoke opening cover illustrated in FIGS. 23 and 24 installed thereon;

FIG. 26 is a side elevational view of the rear brake disc hub in accordance with a second embodiment of the present invention with the sprockets removed;

FIG. 27 a side elevational view of the rear brake disc hub illustrated in FIG. 26 in accordance with a second embodiment of the present invention with certain portions broken away for purposes of illustration;

FIG. 28 is a side elevational view of the front brake disc hub in accordance with a second embodiment of the present invention with the sprockets removed;

FIG. 29 a side elevational view of the front brake disc hub illustrated in FIG. 28 in accordance with a second embodiment of the present invention with certain portions broken away for purposes of illustration;

FIG. 30 is a side elevational view of a front hub of a front wheel with certain portions broken away for purposes of illustration;

FIG. 31 is a side elevational view of a rear hub for a rear wheel with certain portions broken away for purposes of illustration;

FIG. 32 is a side elevational view of a rear brake disk hub for a rear wheel, with spoke opening covers coupled thereto;

FIG. 33 is a side elevational view of the rear brake disk hub illustrated in FIG. 32 with certain portions broken away for purposes of illustration and a pair of spokes attached thereto;

FIG. 34 is an exploded side elevational view of a seal with a seal support for the rear brake disk hub illustrated in FIGS. 32 and 33 with the upper portions broken away for purposes of illustration;

FIG. 35 is an end elevational view of a spoke opening cover illustrated in FIG. 32; and

FIG. 36 is a side elevational view of the spoke opening cover illustrated in FIGS. 32 and 35 in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIGS. 1–3, a bicycle 10 is illustrated with certain parts being modified in accordance with the present invention as discussed below. The bicycle 10 basically has a frame 12 with a front fork 13 movably coupled thereto. A rear wheel 14 is rotatably coupled to a rear portion of the frame 12, while a front wheel 16 is rotatably coupled to the front fork 13. The frame 12 also has a seat 18 adjustably coupled to frame 12, a handlebar 19 coupled to front fork 13 for turning front wheel 16 and a drive train 20 for propelling bicycle 10. The bicycle 10 is also provided with a pair of disc brake assemblies 21 having a caliper 21*a* and a brake lever 21*b*.

Since these parts of bicycle 10 are well known in the art, these parts will not be discussed or illustrated in detail herein, except as they are modified in accordance with the present invention. Moreover, various conventional bicycle parts such as brakes, derailleurs, additional sprocket, etc., which are not illustrated and/or discussed in detail herein, can be used in conjunction with the present invention.

As seen in FIG. 2, the rear wheel 14 has a rear hub 22, a plurality of spokes 24 extending outwardly from the rear hub 22, a rim 26 coupled to the outer ends of spokes 24 by spoke nipples 28, and a tire 30 located on the outer surface of rim 26. The rear hub 22 is also provided with a brake disc rotor 32 that is attached to the rear hub 22 by six blots 32*a* and six nuts 32*b*, as explained below. While the illustrated embodiment is a thirty-six spoke wheel, it will be apparent to those skilled in the art from this disclosure that other spoke arrangements are possible without departing from the present invention. For example, a thirty-two spoke wheel or

a forty spoke wheel can be constructed in accordance with the present invention without departing from the present invention. Basically, the number of spoke openings depends upon the rim to be used with the hub of the present invention.

Preferably, the spokes **24**, the rim **26** and spoke nipples **28** are all conventional parts that are used with the rear hub **22** of the present invention as seen in FIG. **3**. In other words, the unique design of the rear hub **22** allows it to be used with conventional parts, e.g., tangential spokes **24** and a conventional rim **26**. Accordingly, when the rear wheel **14** is assembled, the spokes **24** extend tangentially from an imaginary circle centered on the center axis of rotation of rear hub **22**. In the illustrated embodiment of FIGS. **2–5**, the rear hub **22** and the rim **26** has thirty-six of the spokes **24** coupled therebetween.

The term "tangential spokes" are spokes that have a straight section **24***a* and a bent end **24***b* with an enlarged head **24***c* such that straight section **24***a* extends at an angle of about 95° relative to the bent end **24***b*. Such spokes are well known in the bicycle art. As seen in FIG. **3**, the spokes **24** of the illustrated embodiment each have an outer threaded end **24***d* that is located at the opposite end of the center straight section **24***a* from the bent end **24***b* (inner end portion) with the enlarged head **24***c*. The bent end **24***b* has a center axis that forms an angle of about 95° with the center axis of the straight section **24***a*. The bent ends **24***b* of the spokes **24** are designed to be received within the first and second spoke openings. In particular, the enlarged heads **24***c* of the spokes **24** engage an interior surface of the hub body **38** with the straight sections **24***a* extending substantially tangentially to an imaginary circle with a center on the center axis of rotation of the rear hub **22**.

The rim **26** can be any conventional rim that has a plurality of spoke holes **34** for receiving the spoke nipples **28** for attaching the outer threaded ends **24***d* of the spokes **24** thereto. In the illustrated embodiment, the rim **26** is a conventional steel or alloy rim having a U-shaped cross section with thirty-six spoke holes **34**. The spoke holes **34** are equally spaced apart in a circumferential direction. The spoke holes **34** are preferably lie in a single plane P that divides the cross section in half as seen in FIG. **3**. Of course, rims with fewer or more spoke holes **34** can be used with a hub of the present invention, if needed and/or desired. For example, the rim **26** can have thirty-two spoke holes instead of thirty-six spoke holes, if the rear hub **22** is modified to have fewer holes as explained below.

Rear Hub 22

As best seen in FIG. **5**, the rear hub **22** basically includes a hub axle **36**, a hub body or shell **38**, a first bearing assembly **40***a*, a second bearing assembly **40***b*, a first spoke seal **42***a*, a second spoke seal **42***b*, a freewheel **44** and a quick release mechanism **46**. Of the parts of rear hub **22**, only the hub body **38** and the first and second spoke seals **42***a* and **42***b* are non-conventional parts. The remaining parts of rear hub **22** are relatively conventional, and thus, the remaining parts of rear hub **22** will not be discussed or illustrated in detail herein.

The hub axle **36** has a center axis A extending between a first end **36***a* and a second end **36***b*. The quick release mechanism **46** extends through a center bore **36***c* of the hub axle **36** such that the quick release mechanism **46** is coupled to the hub axle **36** in a conventional manner. The first and second ends **36***a* and **36***b* of the hub axle **36** are threaded for receiving a pair of nuts **50***a* and **50***b* that applies an axial force on the hub body **38**, the bearing assemblies **40***a* and **40***b*, the spoke seals **42***a* and **42***b*, and the freewheel **44**. First and second bearing assemblies **40***a* and **40***b* rotatably mount the hub body **38** with the freewheel **44** on the hub axle **36**. The freewheel **44** allows the hub axle **36** to rotate freely relative to the hub body **38** in one direction, but fixedly couples the hub axle **36** relative to the hub body **38** in the opposite rotational direction.

The hub body **38** is illustrated in accordance with one embodiment of the present invention. In this embodiment, the hub body **38** is a hollow member that defines an interior passageway **52** with the hub axle **36** being rotatably supported therein by the first and second bearing assemblies **40***a* and **40***b*. Thus, the hub body **38** is a substantially tubular member. Specifically, the hub body **38** has a center tubular portion **38***c* with first and second end sections **38***a* and **38***b* being integral formed with the center tubular portion **38***c* as a one-piece, unitary member. The first end section **38***a* has an integrally mounted brake rotor attachment portion **38***d*, while a second end section **38***b* has the freewheel **44** fixedly coupled thereto.

A set of first spoke openings **60***a* are provided at the first end section **38***a* of the hub body **38** for receiving the bent ends **24***b* of the spokes **24**. Similarly, the second end section **38***b* of the hub body **38** is provided with a second set of spoke openings **60***b* for receiving the bent ends **24***b* of the spokes **24**. In the illustrated embodiment, the first end section **38***a* is provided with nine of the first spoke openings **60***a* and the second end section **38***b* is provided with nine of the second spoke openings **60***b*. The spoke openings **60***a* and **60***b* are equally spaced apart about the circumference of the hub body **38**. Each of the spoke openings **60***a* and **60***b* are also designed to receive two spokes **24** as explained below. Accordingly, the rear hub **22** is designed to have thirty-six spokes extending outwardly therefrom in a generally tangential direction.

Preferably, the first and second sets of spoke openings **60***a* and **60***b* are identical. The first and second spoke openings **60***a* and **60***b* are designed to be used with conventional tangential spokes **24**. Of course, it is possible that the first and second sets of spoke openings **60***a* and **60***b* can be different such that tangential spokes **24** are used in one end of the hub body **38** and a different types of spokes are used in the other end of the hub body **38**. The first spoke openings **60***a* are circumferentially arranged around the hub body **38** adjacent to the brake rotor attachment portion **38***d*. Preferably, the first spoke openings **60***a* are spaced axially inward of the brake rotor attachment portion **38***d* so that brake disc rotor **32** can be easily attached with the bolts **32***a* and nuts **32***b*.

In this embodiment, the first and second spoke openings **60***a* and **60***b* are elongated slots that are each provided with an insertion portion **61** and a pair of retaining portions **62**. Accordingly, each of the spoke openings **60***a* and **60***b* is designed to have a pair of spokes **24** retained therein with the spokes **24** extending in opposite directions.

The insertion portion **61** of each spoke opening is located between the pair of retaining portions **62** of each spoke opening. Each insertion portion **61** is formed by a pair of opposed curved surfaces **64** that are spaced apart so as to be equal to or slightly larger than the widths or diameters of the enlarged heads **24***c* of the spokes **24**. Thus, the inner ends (bent ends **24***b* with enlarged heads **24***c*) of the spokes **24** can be easily inserted into the spoke openings **60***a* and **60***b* through the insertion portions **61**.

The retaining portions **62** have smaller widths or diameters than the insertion portions **61**. More specifically, the

diameters or widths of the retaining portions **62** are smaller than the diameters or widths of the enlarged heads **24***c* of the spokes **24** so as to retain the spokes **24** within the spoke openings **60***a* and **60***b*. The retaining portions **62** are each preferably defined by a partial cylindrical surface **66** that is connected to the curved surfaces **64** of the associated insertion portion **61** by a pair of straight surfaces **68**.

The spoke openings **60***a* and **60***b* are formed as elongated slots that are angled relative to the axis A. Accordingly, the insertion portions **61** are arranged in a circumferential pattern with one set of the retaining portions **62** being located axially outward from the insertion portions **61** and the other set of retaining portions **62** being spaced axially inward from the insertion portions **61**. In other words, a first set of retaining portions **62** form an outer circumferential row of the retaining portions **62**, and a second set of the retaining portions **62** form an inner circumferential row of retaining portions **62** with the insertion portions **61** being located between the rows of retaining portions **62**.

Preferably, the insertion portion **61** and the retaining portions **62** of each spoke opening are formed simultaneously. Also preferably, the inner and outer ends of the retaining portions **62** of the spoke openings **60***a* and **60***b* are tapered to avoid sharp edges engaging the spokes **24**.

Each of the insertion portions **61** has a center longitudinal axis C_1 that passes through the center axis A of the hub axle **36**. The retaining portions **62**, on the other hand, have center longitudinal axes C_2 that are parallel to the center longitudinal axis C_1 of the insertion portion **61** for each of the spoke openings **60***a* and **60***b*. Thus, the center longitudinal axes C_2 of the retaining portions **62** do not pass through the center axis of the hub axle **36**. Rather, the center longitudinal axes C_2 of the retaining portions **62** are angled with respect to center axis A. Preferably, the center longitudinal axis C_2 of each retaining portion **62** is angled between about 5° and about 20° from a radial orientation in the hub body **38**. In the illustrated embodiment, the retaining portions **62** are angled about 10° with respect to center axis A for a twenty-six inch rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. For a twenty-six inch rim with thirty-two spoke holes and a hub having a diameter approximately 22 millimeters, the retaining portions **62** are preferably angled about 11° with respect to center axis A. This angled configuration of the retaining portions **62** results in the straight sections **24***a* of the spokes **24** being easily arranged in a tangential direction relative to an imaginary circle centered on the hub body **38**. Moreover, this angled configuration of the retaining portions **62** allows the straight sections **24***a* of the spokes **24** to be easily aligned with the spoke holes **34** of the rim **26** without significant bending of the spokes **24**. In the illustrated embodiment, the spokes **24** are not bent more than about five degrees. Of course, the less bending of the spokes **24**, the better.

If the retaining portions **62** were formed with their center axis passing through the center axis A of the hub axle **36**, then the conventional spokes **24** would be placed under excessive bending forces, which could result in the spokes **24** breaking during use of the wheel. In particular, if the retaining portions **62** have their center axes passing through the center of the hub axle **36**, then the center straight section **24***a* would have to be bent from 95° to 108° for a twenty-six inch rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. In contrast, with the retaining portions **62** of the spokes **24** being angled, the amount of bending of the spokes **24** can be reduced and/or eliminated.

The brake rotor attachment portion **38***d* is integrally formed with the center tubular portion **38***c* of the hub body **38** as a one-piece, unitary member. In the illustrated embodiment, the brake rotor attachment portion **38***d* is formed with six attachment members or points with through bores **70**. While six individual attachment points are illustrated, it will be apparent to those skilled in the art from this disclosure that fewer or more attachment points can be utilized. Moreover, it will be apparent to those skilled in the art from this disclosure that the attachment portions could be a continuous flange, if needed and/or desired. The through bore **70** can be threaded (FIG. **7**) or unthreaded (bores **70'** of FIG. **8**). By using through bores **70** instead of blind bores, the rear hub **22** can be easily manufactured at a relatively lower cost.

As seen in FIG. **8**, the through bores **70"** can be unthreaded bores. In the case of unthreaded through bores **70"**, the bolts **32***a* extend into openings in the brake disc rotor **32** and then through the through bores **70"**. The free ends of the bolts **32***a* have nuts **32***b* threaded thereon for attaching the brake disc rotor **32** to the hub body **38**. This arrangement allows the hub body **38** and the brake rotor attachment portion **38***d* to be formed out of the same a lightweight material, such as aluminum. In this arrangement, the hub body **38** does not need to be replaced if the through bores **70"** become damaged.

As seen in FIG. **7**, the through bores **70** are threaded. In the case of threaded through bores **70**, the bolts **32***a* extend into openings in the brake disc rotor **32** and then threaded into the through bores **70**. Optionally, the free ends of the bolts **32***a* can have the nuts **32***b* threaded thereon for more securely attaching the brake disc rotor **32** to the hub body **38**. In this arrangement, if the threads of through bores **70** become damaged, the hub body **38** does not need to be replaced. Rather, the bolts **32***a* and the nuts **32***b* securely attach the brake disc rotor **32** to the hub body **38**.

Bearing assemblies **40***a* and **40***b* rotatably supports hub body **38** on hub axle **36**. The bearing assembly **40***a* basically includes a plurality of balls **74***a* located between an inner race member **76***a* and an outer race member **78***a*. Similarly, the bearing assembly **40***b* basically includes a plurality of balls **74***b* located between an inner race member **76***b* and an outer race member **78***b*. Since bearing assemblies **40***a* and **40***b* are well known in the bicycle art, they will not be discussed or illustrated in detail herein.

Turning now to FIGS. **13** and **14**, the spoke seals **42***a* and **42***b* are arranged in the interior passageway **52** of the hub body **38** so as to be adjacent the spoke openings **60***a* and **60***b* to isolate the spoke openings **60***a* and **60***b* from the hub axle **36**. In other words, the spoke seals **42***a* and **42***b* prevent contaminants from entering the rear hub **22** through the spoke openings **60***a* and **60***b*. The spoke seals **42***a* and **42***b* are preferably resilient members that are constructed of rubber or the like. Of course, it will be apparent to those skilled in the art from this disclosure that the seals could be created from other types of materials, depending upon their shape and arrangement. Moreover, it will be apparent to those skilled in the art from this disclosure that while the spoke seals **42***a* and **42***b* are illustrated as a pair of separate sealing members, the spoke seals **42***a* and **42***b* can be formed as a one-piece, unitary member.

In the preferred embodiment, the spoke seals **42***a* and **42***b* also aid in the assembly of the spokes **24** with the hub body **38** and the rim **26**. Specifically, in the preferred embodiments, the seals **42***a* and **42***b* are arranged so that they restrain movement of the spokes **24** within the spoke openings **60***a* and **60***b* so that the bent ends **24***b* of the spokes **24** stays in the retaining portions **62** of the spoke openings **60***a* and **60***b*.

In the illustrated embodiment, the spoke seal **42***a* has a tubular section **80***a* and a center annular flange **82***a*. The center annular flange **82***a* extends in a circumferential direction about the tubular section **80***a*. The center annular flange **82***a* can either contact the interior surface of the tubular section **80***a* or be spaced from the tubular section **80***a*. The ends **84***a* and **86***a* of the tubular section **80***a* are configured to engage a ring member **88***a* and an abutment **90***a* of the inner surface of the hub body **38**. Of course, the particular shape of the ends **84***a* and **86***a* will vary depending on the shape of the hub body **38** and its internal components. Preferably, ends **84***a* and **86***a* of the tubular section **80***a* are annular flanges that contact the interior surface of the tubular section **80***a* to form an isolated area beneath the spoke openings **60***a*. This isolated area beneath the spoke openings **60***a* is a continuous annular space.

When the rear hub **22** is assembled, an axial force is applied to the ends **84***a* and **86***a* of the tubular section **80***a* to form annular seals therebetween. Accordingly, the spoke seal **42***a* isolates a first interior section of the interior passageway **52** from the remainder of the interior passageway **52**. This interior section formed by the spoke seal **42***a* is continuous annular first space located beneath the spoke openings **60***a*.

The center annular flange **82***a* is preferably aligned with a radial plane passing through the centers axes C_1 of the insertion portions **61** of the first spoke openings **60***a*. Thus, the center annular flange **82***a* is positioned to axially separate the two retaining portions **62** of each of the first spoke openings **60***a* from each other. The center annular flange **82***a* is also positioned to keep spokes **24** in the retaining portions **62** of the first spoke openings **60***a*. Accordingly, when the enlarged heads **24***c* of the spokes **24** are inserted into the insertion portions **61** of the spoke openings **60***a*, the enlarged heads **24***c* of the spokes **24** contact the center annular flange **82***a*. The enlarged heads **24***c* then pushes or deforms the center annular flange **82***a* one way or the other so that the enlarged heads **24***c* extends into the insertion portions **61** of the spoke openings **60***a*. The spokes **24** are then moved or slid into one of the two retaining portions **62** of each of the spoke openings **60***a*. The center annular flange **82***a* will prevent the spokes **24** from accidentally falling out of the insertion portions **61** of the spoke openings **60***a*. Thus, the center annular flange **82***a* aids in the assembly of the rear wheel **14**. In other words, the center annular flange **82***a* must be moved or deformed again before the spokes **24** can be removed from the spoke openings **60***a*. For added resiliency, an annular groove **92***a* can be formed in the outer peripheral surface of the center flange **82***a*.

Similar to the spoke seal **42***a*, the spoke seal **42***b* has a tubular section **80***b* and a center annular flange **82***b*. The center annular flange **82***a* extends in a circumferential direction about the tubular section **80***a*. Alternatively, the center annular flanges **82***a* and **82***b* of the spoke seals **42***a* and **42***b* can each have a pair of center annular flanges. The ends **84***b* and **86***b* of the tubular section **80***b* are configured to engage a ring member **88***b* and an abutment **90***b* of the inner surface of the hub body **38**. Of course, the particular shape of the ends **84***b* and **86***b* will vary depending on the shape of the hub body **38** and its internal components. Preferably, ends **84***b* and **86***b* of the tubular section **80***b* are annular flanges that contact the interior surface of the tubular section **80***b* to form an isolated area beneath the spoke openings **60***b*. This isolated area beneath the spoke openings **60***b* is a continuous annular space.

When the rear hub **22** is assembled, an axial force is applied to the ends **84***b* and **86***b* of the tubular section **80***b* to form annular seals therebetween. Accordingly, the spoke seal **42***b* isolates a second interior section of the interior passageway **52** from the remainder of the interior passageway **52**. This interior section formed by the spoke seal **42***b* is continuous annular second space located beneath the spoke openings **60***b*.

Similar to the center annular flange **82***a*, the center annular flange **82***b* is preferably aligned with a radial plane passing through the centers axes C_1 of the insertion portions **61** of the second spoke openings **60***b*. Thus, the center annular flange **82***b* is positioned to axially separate the two retaining portions **62** of each of the second spoke openings **60***b* from each other. The center annular flange **82***b* is also positioned to keep spokes **24** in the retaining portions **62** of the second spoke openings **60***b*. Accordingly, when the enlarged heads **24***c* of the spokes **24** are inserted into the insertion portions **61** of the spoke openings **60***b*, the enlarged heads **24***c* of the spokes **24** contact the center annular flange **82***b*. The enlarged heads **24***c* then pushes or deforms the center annular flange **82***b* one way or the other so that the enlarged heads **24***c* extends into the insertion portions **61** of the spoke openings **60***b*. The spokes **24** are then moved or slid into one of the two retaining portions **62** of each of the spoke openings **60***b*. The center annular flange **82***b* will prevent the spokes **24** from accidentally falling out of the insertion portions **61** of the spoke openings **60***b*. Thus, the center annular flange **82***b* aids in the assembly of the rear wheel **14**. In other words, the center annular flange **82***b* must be moved or deformed again before the spokes **24** can be removed from the spoke openings **60***b*. For added resiliency, an annular groove **92***b* can be formed in the outer peripheral surface of the center flange **82***b*.

The freewheels, such as the freewheel **44**, are well known in the bicycle art, and thus, the freewheel **44** will not be illustrated or discussed in detail herein. The freewheel **44** is used to transmit a driving force from the chain to the rear bicycle wheel in one rotation direction only. The freewheel **44** allows the bicycle **10** to advance freely without any rotation of the pedals. The freewheel **44** is fastened to the rear hub **22** as integral part of the rear hub **22** in a conventional manner. The freewheel **44** has an outer tubular part **94**, an inner tubular part **96** and a one-way clutch **98**. The inner tubular part **96** is installed radially inwardly of the outer tubular part **94** so that the inner tubular part **96** is free to rotate relative to the outer tubular part **94**. The one-way clutch **98** is installed between the outer tubular part **94** and inner tubular part **96** for transmitting the driving force from the outer tubular part **94** to the inner tubular part **96** in one rotational direction only. The outer tubular part **94** has a plurality of gears or sprockets (not shown) mounted thereon, while the inner tubular part **96** is usually mounted on the hub axle **36**.

Front Hub 22'

Turning now to FIGS. **15** and **16**, the front hub **22'** is illustrated in accordance with the present invention. The front hub **22'** is substantially the same as the rear hub **22**, except that the front hub **22'** does not have a freewheel and the spoke openings **60***a'* and **60***b'* are angled in the opposite direction from spoke openings **60***a* and **60***b* of the rear hub **22**. Moreover, the front hub **22'** is used with spokes **24** and rim **26** discussed above. Since the front hub **22'** is substantially the same as the rear hub **22**, the front hub **22'** will not be discussed or illustrated in detail herein.

The front hub **22'** basically includes a hub axle **36'**, a hub body or shell **38'**, a first bearing assembly **40***a'*, a second

bearing assembly 40*b*', a first spoke seal 42*a*', a second spoke seal 42*b*' and a quick release mechanism 46'. Of the parts of front hub 22', only the hub body 38' and the first and second spoke seals 42*a*' and 42*b*' are non-conventional parts. The remaining parts of front hub 22' are relatively conventional, and thus, the remaining parts of front hub 22' will not be discussed or illustrated in detail herein.

The hub axle 36' has a center axis A extending between a first end 36*a*' and a second end 36*b*'. The quick release mechanism 46' extends through a center bore 36*c*' of the hub axle 36' such that the quick release mechanism 46' is coupled to the hub axle 36' in a conventional manner. The first and second ends 36*a*' and 36*b*' of the hub axle 36' are threaded for receiving a pair of nuts 50*a*' and 50*b*' that applies an axial force on the hub body 38', the bearing assemblies 40*a*' and 40*b*' and the spoke seals 42*a*' and 42*b*'. First and second bearing assemblies 40*a*' and 40*b*' rotatably mount the hub body 38' on the hub axle 36'.

The hub body 38' is illustrated in accordance with one embodiment of the present invention. In this embodiment, the hub body 38' is a hollow member that defines an interior passageway 52' with the hub axle 36' being rotatably supported therein by the first and second bearing assemblies 40*a*' and 40*b*'. Thus, the hub body 38' is a substantially tubular member. Specifically, the hub body 38' has a center tubular portion 38*c*' with first and second end sections 38*a*' and 38*b*' being integral formed with the center tubular portion 38*c*' as a one-piece, unitary member. The first end section 38*a*' has an integrally mounted brake rotor attachment portion 38*d*'.

A set of first spoke openings 60*a*' are provided at the first end section 38*a*' of the hub body 38' for receiving the bent ends 24*b* of the spokes 24. Similarly, the second end section 38*b*' of the hub body 38' is provided with a second set of spoke openings 60*b*' for receiving the bent ends 24*b* of the spokes 24. In the illustrated embodiment, the first end section 38*a*' is provided with nine of the first spoke openings 60*a*' and the second end section 38*b*' is provided with nine of the second spoke openings 60*b*'. The spoke openings 60*a*' and 60*b*' are equally spaced apart about the circumference of the hub body 38'. Each of the spoke openings 60*a*' and 60*b*' are also designed to receive two spokes 24 as explained below. Accordingly, the front hub 22' is designed to have thirty-six spokes extending outwardly therefrom in a generally tangential direction.

Preferably, the first and second sets of spoke openings 60*a*' and 60*b*' are identical. The first and second spoke openings 60*a*' and 60*b*' are designed to be used with conventional tangential spokes 24. Of course, it is possible that the first and second sets of spoke openings 60*a*' and 60*b*' can be different such that tangential spokes 24 are used in one end of the hub body 38' and a different types of spokes are used in the other end of the hub body 38'. The first spoke openings 60*a*' are circumferentially arranged around the hub body 38' adjacent to the brake rotor attachment portion 38*d*'. Preferably, the first spoke openings 60*a*' are spaced axially inward of the brake rotor attachment portion 38*d*' so that brake disc rotor 32' can be easily attached with the bolts 32*a*' and nuts 32*b*'.

In this embodiment, the first and second spoke openings 60*a*' and 60*b*' are elongated slots that are each provided with an insertion portion 61' and a pair of retaining portions 62'. Accordingly, each of the spoke openings 60*a*' and 60*b*' is designed to have a pair of spokes 24 retained therein with the spokes 24 extending in opposite directions.

The insertion portion 61' of each spoke opening is located between the pair of retaining portions 62' of each spoke opening. Each insertion portion 61' is formed by a pair of opposed curved surfaces 64' that are spaced apart so as to be equal to or slightly larger than the widths or diameters of the enlarged heads 24*c* of the spokes 24. Thus, the inner ends (bent ends 24*b* with enlarged heads 24*c*) of the spokes 24 can be easily inserted into the spoke openings 60*a*' and 60*b*' through the insertion portions 61'.

The retaining portions 62' have smaller widths or diameters than the insertion portions 61'. More specifically, the diameters or widths of the retaining portions 62' are smaller than the diameters or widths of the enlarged heads 24*c* of the spokes 24 so as to retain the spokes 24 within the spoke openings 60*a*' and 60*b*'. The retaining portions 62' are each preferably defined by a partial cylindrical surface 66' that is connected to the curved surfaces 64' of the associated insertion portion 61' by a pair of straight surfaces 68'.

The spoke openings 60*a*' and 60*b*' are formed elongated slots that are angled relative to the axis A'. Accordingly, the insertion portions 61' are arranged in a circumferential pattern with one set of the retaining portions 62' being located axially outward from the insertion portions 61' and the other set of retaining portions 62' being spaced axially inward from the insertion portions 61'. In other words, a first set of retaining portions 62' form an outer circumferential row of the retaining portions 62' , and a second set of the retaining portions 62' form an inner circumferential row of retaining portions 62' with the insertion portions 61' being located between the rows of retaining portions 62'.

Preferably, the insertion portion 61' and the retaining portions 62' of each spoke opening are formed simultaneously. Also preferably, the inner and outer ends of the retaining portions 62' of the spoke openings 60*a*' and 60*b*' are tapered to avoid sharp edges engaging the spokes 24.

Each of the insertion portions 61' has a center longitudinal axis C_1' that passes through the center axis A' of the hub axle 36'. The retaining portions 62', on the other hand, have center longitudinal axes C_2' that are parallel to the center longitudinal axis C_1' of the insertion portion 61' for each of the spoke openings 60*a*' and 60*b*'. Thus, the center longitudinal axes C_2' of the retaining portions 62' do not pass through the center axis of the hub axle 36'. Rather, the center longitudinal axes C_2' of the retaining portions 62' are angled with respect to center axis A'. Preferably, the center longitudinal axis C_2' of each retaining portion 62' is angled between about 5° and about 20° from a radial orientation in the hub body 38'. In the illustrated embodiment, the retaining portions 62' are angled about 10° with respect to center axis A for a twenty-six inch rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. For a twenty-six inch rim with thirty-two spoke holes and a hub having a diameter approximately 22 millimeters, the retaining portions 62' are preferably angled about 11° with respect to center axis A'. This angled configuration of the retaining portions 62' results in the straight sections 24*a* of the spokes 24 being easily arranged in a tangential direction relative to an imaginary circle centered on the hub body 38'. Moreover, this angled configuration of the retaining portions 62' allows the straight sections 24*a* of the spokes 24 to be easily aligned with the spoke holes 34 of the rim 26 without significant bending of the spokes 24. In the illustrated embodiment, the spokes 24 are not bent more than about five degrees.

If the retaining portions 62' were formed with their center axis passing through the center axis A of the hub axle 36', then the conventional spokes 24 would be placed under excessive bending forces, which could result in the spokes

24 breaking during use of the wheel. In particular, if the retaining portions 62' have their center axes passing through the center of the hub axle 36', then the center straight section 24*a* would have to be bent from 95° to 108° for a twenty-six inch rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. In contrast, with the retaining portions 62' of the spokes 24 being angled, the amount of bending of the spokes 24 can be reduced and/or eliminated.

The brake rotor attachment portion 38*d*' is integrally formed with the center tubular portion 38*c*' of the hub body 38' as a one-piece, unitary member. In the illustrated embodiment, the brake rotor attachment portion 38*d*' is formed with six attachment members or points with through bores 70'. While six individual attachment points are illustrated, it will be apparent to those skilled in the art from this disclosure that fewer or more attachment points can be utilized. Moreover, it will be apparent to those skilled in the art from this disclosure that the attachment portions could be a continuous flange, if needed and/or desired. The through bore 70' can be threaded or unthreaded. By using through bores 70' instead of blind bores, the front hub 22' can be easily manufactured at a relatively lower cost.

In the case of unthreaded through bores 70', the bolts 32*a*' extend into openings in the brake disc rotor 32' and then through the through bores 70'. The free ends of the bolts 32*a*' have nuts 32*b*' threaded thereon for attaching the brake disc rotor 32' to the hub body 38'. This arrangement allows the hub body 38' and the brake rotor attachment portion 38*d*' to be formed out of the same a lightweight material, such as aluminum. Moreover, the hub body 38' does not need to be replaced if the through bores 70' become damaged.

In the case of threaded through bores 70', the bolts 32*a*' extend into openings in the brake disc rotor 32' and then threaded into the through bores 70'. Optionally, the free ends of the bolts 32*a*' can have the nuts 32*b*' threaded thereon for more securely attaching the brake disc rotor 32' to the hub body 38'. In this arrangement, if the threads of through bores 70' become damaged, the hub body 38' does not need to be replaced. Rather, the bolts 32*a*' and the nuts 32*b*' securely attach the brake disc rotor 32' to the hub body 38'.

Bearing assemblies 40*a*' and 40*b*' rotatably supports hub body 38' on hub axle 36'. The bearing assembly 40*a*' basically includes a plurality of balls 74*a*' located between an inner race member 76*a*' and an outer race member 78*a*'. Similarly, the bearing assembly 40*b*' basically includes a plurality of balls 74*b*' located between an inner race member 76*b*' and an outer race member 78*b*'. Since bearing assemblies 40*a*' and 40*b*' are well known in the bicycle art, they will not be discussed or illustrated in detail herein.

Turning now to FIGS. 17 and 18,the spoke seals 42*a*' and 42*b*' are arranged in the interior passageway 52' of the hub body 38' so as to be adjacent the spoke openings 60*a*' and 60*b*' to isolate the spoke openings 60*a*' and 60*b*' from the hub axle 36. In other words, the spoke seals 42*a*' and 42*b*' prevent contaminants from entering the front hub 22' through the spoke openings 60*a*' and 60*b*'. The spoke seals 42*a*' and 42*b*' are preferably resilient members that are constructed of rubber or the like. Of course, it will be apparent to those skilled in the art from this disclosure that the seals could be created from other types of materials, depending upon their shape and arrangement. Moreover, it will be apparent to those skilled in the art from this disclosure that while the spoke seals 42*a*' and 42*b*' are illustrated as a pair of separate sealing members, the spoke seals 42*a*' and 42*b*' can be formed as a one-piece, unitary member.

In the preferred embodiment, the spoke seals 42*a*' and 42*b*' also aid in the assembly of the spokes 24 with the hub body 38' and the rim 26. Specifically, in the preferred embodiments, the seals 42*a*' and 42*b*' are arranged so that they restrain movement of the spokes 24 within the spoke openings 60*a*' and 60*b*' so that the bent ends 24*b* of the spokes 24 stays in the retaining portions 62' of the spoke openings 60*a*' and 60*b*'.

In the illustrated embodiment, the spoke seal 42*a*' has a tubular section 80*a*' and a center annular flange 82*a*'. The center annular flange 82*a*' extends in a circumferential direction about the tubular section 80*a*'. The ends 84*a*' and 86*a*' of the tubular section 80*a*' are configured to engage a ring member 88*a*' and an abutment 90*a*' of the inner surface of the hub body 38'. Of course, the particular shape of the ends 84*a*' and 86*a*' will vary depending on the shape of the hub body 38' and its internal components. In other words, the spoke seal 42*a*' functions the same way as the spoke seal 42*a* of the rear hub 22, but has a slightly modified ends 84*a*' and 86*a*' to accommodate front hub 22'.

When the front hub 22' is assembled, an axial force is applied to the ends 84*a*' and 86*a*' of the tubular section 80*a*' to form annular seals therebetween. Accordingly, the spoke seal 42*a*' isolates a first interior section of the interior passageway 52' from the remainder of the interior passageway 52'. This interior section formed by the spoke seal 42*a*' is continuous annular first space located beneath the spoke openings 60*a*'.

The center annular flange 82*a*' is preferably aligned with a radial plane passing through the centers axes C_1' of the insertion portions 61' of the first spoke openings 60*a*'. Thus, the center annular flange 82*a*' is positioned to axially separate the two retaining portions 62' of each of the first spoke openings 60*a*' from each other. The center annular flange 82*a*' is also positioned to keep spokes 24 in the retaining portions 62' of the first spoke openings 60*a*'. Accordingly, when the enlarged heads 24*c* of the spokes 24 are inserted into the insertion portions 61 of the spoke openings 60*a*', the enlarged heads 24*c* of the spokes 24 contact the center annular flange 82*a*'. The enlarged heads 24*c* then pushes or deforms the center annular flange 82*a*' one way or the other so that the enlarged heads 24*c* extends into the insertion portions 61' of the spoke openings 60*a*'. The spokes 24 are then moved or slid into one of the two retaining portions 62' of each of the spoke openings 60*a*. The center annular flange 82*a*' will prevent the spokes 24 from accidentally falling out of the insertion portions 61' of the spoke openings 60*a*'. Thus, the center annular flange 82*a*' aids in the assembly of the front wheel 16. In other words, the center annular flange 82*a*' must be moved or deformed again before the spokes 24 can be removed from the spoke openings 60*a*'. For added resiliency, an annular groove 92*a*' can be formed in the outer peripheral surface of the center flange 82*a*'.

Similar to the spoke seal 42*a*', the spoke seal 42*b*' has a tubular section 80*b*' and a center annular flange 82*b*'. The center annular flange 82*a*' extends in a circumferential direction about the tubular section 80*a*'. Alternatively, the center annular flanges 82*a*' and 82*b*' of the spoke seals 42*a*' and 42*b*' can each have a pair of center annular flanges. The ends 84*b*' and 86*b*' of the tubular section 80*b*' are configured to engage a ring member 88*b*' and an abutment 90*b*' of the inner surface of the hub body 38'. Of course, the particular shape of the ends 84*b*' and 86*b*' will vary depending on the shape of the hub body 38' and its internal components. When the front hub 22' is assembled, an axial force is applied to the ends 84*b*' and 86*b*' of the tubular section 80*b*' to form annular seals therebetween. Accordingly, the spoke seal 42*b*' isolates

a second interior section of the interior passageway **52'** from the remainder of the interior passageway **5'**. This interior section formed by the spoke seal **42***b'* is continuous annular second space located beneath the spoke openings **60***b'*.

Similar to the center annular flange **82***a'*, the center annular flange **82***b'* is preferably aligned with a radial plane passing through the centers axes C_1 of the insertion portions **61'** of the second spoke openings **60***b'*. Thus, the center annular flange **82***b'* is positioned to axially separate the two retaining portions **62'** of each of the second spoke openings **60***b'* from each other. The center annular flange **82***b'* is also positioned to keep spokes **24** in the retaining portions **62'** of the second spoke openings **60***b'*. Accordingly, when the enlarged heads **24***c* of the spokes **24** are inserted into the insertion portions **61'** of the spoke openings **60***b'*, the enlarged heads **24***c* of the spokes **24** contact the center annular flange **82***b'*. The enlarged heads **24***c* then pushes or deforms the center annular flange **82***b'* one way or the other so that the enlarged heads **24***c* extends into the insertion portions **61'** of the spoke openings **60***b'*. The spokes **24** are then moved or slid into one of the two retaining portions **62** of each of the spoke openings **60***b'*. The center annular flange **82***b'* will prevent the spokes **24** from accidentally falling out of the insertion portions **61'** of the spoke openings **60***b'*. Thus, the center annular flange **82***b'* aids in the assembly of the front wheel **16**. In other words, the center annular flange **82***b'* must be moved or deformed again before the spokes **24** can be removed from the spoke openings **60***b'*. For added resiliency, an annular groove **92***b'* can be formed in the outer peripheral surface of the center flange **82***b'*.

Spoke Opening Covers

As seen in FIGS. **19** and **20**, a spoke opening cover **100** in accordance with one embodiment of the present invention is illustrated for use with the front hub **22'** of FIGS. **15** and **16**. Of course, the spoke opening cover **100** can be used with the rear hub **22** of FIGS. **4** and **5** by turning the spoke opening cover **100** inside out to reverse the direction of the slits **102**. Although for purposes of brevity, the spoke opening cover **100** will only be illustrated with the front hub **22'**.

The spoke opening cover **100** is used to limit or prevent contaminants from entering the hub body **38** or **38'** via the spoke openings **60***a,* **60***a'* or **60***b,* **60***b'*, respectively. The spoke opening cover **100** can be used instead of the spoke seals **42***a,* **42***a'* and **42***b,* **42***b'*, or in conjunction with the spoke seals **42***a,* **42***a'* and **42***b,* **42***b'*. The spoke opening cover **100** basically has a resilient tubular body **101** constructed from a flexible material such as rubber. The spoke opening cover **100** has a plurality of slits **102** spaced circumferential around the tubular body **101**. The tubular body **101** of the spoke opening cover **100** is configured and dimensioned to snugly fit around the bicycle hub **22'** so that the spoke openings are aligned with the slits. The spoke opening cover **100** is installed on each end of the hub body **38'** prior to installation of spokes **24**. Since this embodiment is used with the bicycle hubs **22** and **22'**, the slits **102** extend diagonally relative a center axis of the tubular body. The slits **102** have enlarged openings **104** at each end. The enlarged openings **104** align with the retaining portions **62'** of the spoke openings **60***a'* or **60***b'*, while the center sections of the slits **102** overlie the insertion portions **61'** of the spoke openings **60***a'* or **60***b'*. Also, the center sections of the slits **102** hold the spokes **24** in the retaining portions **62'** to aid in the assembly of the wheel.

As seen in FIGS. **21** and **22**, a spoke opening cover **100'** in accordance with an alternate embodiment of the present invention is illustrated for use with the bicycle either the rear hub **22** of FIGS. **4** and **5** or the front hub **22'** of FIGS. **15** and **16**. Although for purposes of brevity, the spoke opening cover **100'** will only be illustrated with the front hub **22'**.

The spoke opening cover **100'** is used to limit or prevent contaminants from entering the hub body **38** or **38'** via the spoke openings **60***a,* **60***a'* or **60***b,* **60***b'*, respectively. The spoke opening cover **100'** can be used instead of the spoke seals **42***a,* **42***a'* and **42***b,* **42***b'*, or in conjunction with the spoke seals **42***a,* **42***a'* and **42***b,* **42***b'*. In this embodiment, the spoke opening cover **100'** is a thin flexible strip or body portion **101'** having a first end **102'** and a second end **104'** with a predetermined length therebetween. The first end **102'** is provided with a first protrusion **106'**, while the second end **104'** is provided with a second protrusion **108'**. The first and second protrusions **106'** and **108'** are configured and dimensioned to be frictionally retained with the insertion portions **61'** of the spoke openings **60***a'* or **60***b'*. Accordingly, the first and second protrusions **106'** and **108'** have predetermined widths or diameters that are larger that a width of an enlarged head **24***c* of a spoke **24**. Preferably, the body portion **101'** has a predetermined width that is larger that the widths or diameters of the enlarged heads **24***c* of the spokes **24**. In other words, the body portion **101'** of the spoke opening cover **100'** has a predetermined width that is larger than a width of insertion portions **61'** of the spoke openings **60***a'* or **60***b'*. The spoke opening cover **100'** is designed to be installed on each end of the hub body **38'** after the spokes **24** have been installed into the spoke openings **60***a'* and **60***b'*.

As seen in FIGS. **23–25**, a spoke opening cover **100"** in accordance with another alternate embodiment of the present invention is illustrated for use with the bicycle either the rear hub **22** of FIGS. **4** and **5** or the front hub **22'** of FIGS. **15** and **16**. Although for purposes of brevity, the spoke opening cover **100"** will only be illustrated with the front hub **22'**.

The spoke opening cover **100"** is used to limit or prevent contaminants from entering the hub body **38** or **38'** via the spoke openings **60***a,* **60***a'* or **60***b,* **60***b'*, respectively. The spoke opening cover **100"** can be used instead of the spoke seals **42***a,* **42***a'* and **42***b,* **42***b'*, or in conjunction with the spoke seals **42***a,* **42***a'* and **42***b,* **42***b'*. In this embodiment, the spoke opening cover **100"** is a thin flexible strip or body portion **101"** having a first end **102"** and a second end **104"** with a predetermined length therebetween.

The first end **102"** is provided with a tubular connector **106"**, while the second end **104"** is provided with a mating connector **108**. The tubular connector **106"** is a protrusion that is configured and dimensioned to be received in one of the insertion portions **61'** of the spoke openings **60***a'* or **60***b'*. The mating connector **108'** is a split protrusion in the form of a resilient detent. The second end **104"** is configured and dimensioned to overlap the first end **102"** with mating connector **108"** being retained in the bore of tubular protrusion **106"** via a snap-fit. The length of body portion **101"** should be such that spoke opening cover **100"** snugly fits around the hub body **38'** when the detent **108"** is snap-fitted into the tubular protrusion **106"**.

Preferably, the body portion **101"** has a predetermined width that is larger than the widths or diameters of the enlarged heads **24***c* of the spokes **24**. In other words, the body portion **101"** of the spoke opening cover **100"** has a predetermined width that is larger than a width of insertion portions **61'** of the spoke openings **60***a'* or **60***b'*. The spoke opening cover **100"** is designed to be installed on each end of the hub body **38'** after the spokes **24** have been installed into the spoke openings **60***a'* and **60***b'*.

Second Embodiment

Referring now to FIGS. **26–29**, bicycle rear and front hubs **122** and **122'** are illustrated in accordance with a second embodiment of the present invention. The rear and front hubs **122** and **122'** of this second embodiment are substantially the same as the first embodiment, except that the spoke hole openings **60***a*, **60***a'* and **60***b*, **60***b'* of the first embodiment have been replaced with modified spoke openings **160***a*, **160***a'* and **160***b*, **160***b'* that each receive a single spoke as explained below. Since the rear and front hubs **122** and **122'** are substantially the same as the rear and front hubs **22** and **22'** of the first embodiment, this embodiment will not be discussed or illustrated in detail herein.

Referring to FIGS. **26** and **27**, the rear hub **122** basically includes a hub axle **136**, a hub body **138**, a first bearing assembly **140***a*, a second bearing assembly **140***b*, a first spoke seal **142***a*, a second spoke seal **142***b*, a freewheel **144** and a quick release mechanism **146**. The hub axle **136** has a center axis A extending between a first end **136***a* and a second end **136***b*.

The quick release mechanism **146** extends through a center bore **136***c* of the hub axle **136** such that the quick release mechanism **146** is coupled to the hub axle **136** in a conventional manner. The first and second ends **136***a* and **136***b* of the hub axle **136** are threaded for receiving a pair of nuts **150***a* and **150***b* that applies an axial force on the hub body **138**, the bearing assemblies **140***a* and **140***b*, the spoke seals **142***a* and **142***b*, and the freewheel **144**. First and second bearing assemblies **140***a* and **140***b* rotatably mount the hub body **138** with the freewheel **144** on the hub axle **136**. The freewheel **144** allows the hub axle **136** to rotate freely relative to the hub body **138** in one direction, but fixedly couples the hub axle **136** relative to the hub body **138** in the opposite rotational direction.

A set of first spoke openings **160***a* are provided at the first end section **138***a* of the hub body **138** for receiving the bent ends **24***b* of the spokes **24**. Similarly, the second end section **138***b* of the hub body **138** is provided with a second set of spoke openings **160***b* for receiving the bent ends **24***b* of the spokes **24**. In the illustrated embodiment, the first end section **138***a* is provided with eighteen of the first spoke openings **160***a* and the second end section **138***b* is provided with eighteen of the second spoke openings **160***b*. The spoke openings **160***a* and **160***b* are grouped into pairs that are equally spaced apart about the circumference of the hub body **138**. Accordingly, the rear hub **122** is designed to have thirty-six spokes extending outwardly therefrom in a generally tangential direction.

Preferably, the first and second sets of spoke openings **160***a* and **160***b* are arranged identical. The first and second spoke openings **160***a* and **160***b* are designed to be used with conventional tangential spokes **24**. Of course, it is possible that the first and second sets of spoke openings **160***a* and **160***b* can be different such that tangential spokes **24** are used in one end of the hub body **138** and a different types of spokes are used in the other end of the hub body **138**. The first spoke openings **160***a* are circumferentially arranged around the hub body **138** adjacent to the brake rotor attachment portion **138***d*. Preferably, the first spoke openings **160***a* are spaced axially inward of the brake rotor attachment portion **138***d* so that brake disc rotor **132** can be easily attached with the bolts **132***a* and nuts **132***b*.

In this embodiment, the spoke openings **160***a* and **160***b* are arranged to form two circumferential rows of spoke openings **160***a* at end section **138***a* and two circumferential rows of spoke openings **160***b* at end section **138***b*. Each of the spoke openings **160***a* and **160***b* has an insertion portion **161** and a retaining portion **162**. Adjacent pairs of the spoke openings **160***a* and **160***b* are oriented in opposite directions so that the spokes **24** extend in generally opposite directions from the hub body **138**.

Each insertion portion **161** is formed by a curved or partial cylindrical surface **164** that has a width or diameter that is equal to or slightly larger than the widths or diameters of the enlarged heads **24***c* of the spokes **24**. Thus, the inner ends (bent ends **24***b* with enlarged heads **24***c*) of the spokes **24** can be easily inserted into the spoke openings **160***a* and **160***b* through the insertion portions **161**.

The retaining portions **162** have smaller widths or diameters than the insertion portions **161**. More specifically, the diameters or widths of the retaining portions **162** are smaller than the diameters or widths of the enlarged heads **24***c* of the spokes **24** so as to retain the spokes **24** within the spoke openings **160***a* and **160***b*. The retaining portions **162** are each preferably defined by a partial cylindrical surface **166** that is connected to the curved surface **164** of the associated insertion portion **161**.

Preferably, the insertion portion **161** and the retaining portions **162** of each spoke opening are formed simultaneously. Also preferably, the inner and outer ends of the retaining portions **162** of the spoke openings **160***a* and **160***b* are tapered to avoid sharp edges engaging the spokes **24**.

Similar to the first embodiment, discussed above, each of the insertion portions **161** has a center longitudinal axis that passes through the center axis A of the hub axle **136**. The retaining portions **162**, on the other hand, have center longitudinal axes that are parallel to the center longitudinal axis of the associated insertion portion **161** for each of the spoke openings **160***a* and **160***b*. Thus, the center longitudinal axes of the retaining portions **162** do not pass through the center axis of the hub axle **136**, similar to the first embodiment. Rather, the center longitudinal axes of the retaining portions **162** are angled with respect to center axis A. Preferably, the center longitudinal axis of each retaining portion **162** is angled between about 5° and about 20° from a radial orientation in the hub body **138**. In the illustrated embodiment, the retaining portions **162** are angled about 10° with respect to center axis A for a twenty-six inch rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. For a twenty-six inch rim with thirty-two spoke holes and a hub having a diameter approximately 22 millimeters, the retaining portions **162** are preferably angled about 11° with respect to center axis A. This angled configuration of the retaining portions **162** results in the straight sections **24***a* of the spokes **24** being easily arranged in a tangential direction relative to an imaginary circle centered on the hub body **138**. Moreover, this angled configuration of the retaining portions **162** allows the straight sections **24***a* of the spokes **24** to be easily aligned with the spoke holes of the rim without significant bending of the spokes **24**. In the illustrated embodiment, the spokes **24** are not bent more than about five degrees.

Referring to FIGS. **28** and **29**, the front hub **122'** basically includes a hub axle **136'**, a hub body **138'**, a first bearing assembly **140***a'*, a second bearing assembly **140***b'*, a first spoke seal **142***a'*, a second spoke seal **142***b'*, and a quick release mechanism **146'**. The hub axle **136'** has a center axis A' extending between a first end **136***a'* and a second end **136***b'*.

The quick release mechanism **146'** extends through a center bore **136***c'* of the hub axle **136'** such that the quick release mechanism **146'** is coupled to the hub axle **136'** in a

conventional manner. The first and second ends **136***a*' and **136***b*' of the hub axle **136**' are threaded for receiving a pair of nuts **150***a*' and **150***b*' that applies an axial force on the hub body **138**', the bearing assemblies **140***a*' and **140***b*' and the spoke seals **142***a*' and **142***b*'. First and second bearing assemblies **140***a*' and **140***b*' rotatably mount the hub body **138**' on the hub axle **136**'.

A set of first spoke openings **160***a*' are provided at the first end section **138***a*' of the hub body **138**' for receiving the bent ends **24***b* of the spokes **24**. Similarly, the second end section **138***b*' of the hub body **138**' is provided with a second set of spoke openings **160***b*' for receiving the bent ends **24***b* of the spokes **24**. In the illustrated embodiment, the first end section **138***a*' is provided with eighteen of the first spoke openings **160***a*' and the second end section **138***b*' is provided with eighteen of the second spoke openings **160***b*'. The spoke openings **160***a*' and **160***b*' are grouped into pairs that are equally spaced apart about the circumference of the hub body **138**'. Accordingly, the front hub **122**' is designed to have thirty-six spokes extending outwardly therefrom in a generally tangential direction.

The first spoke openings **160***a*' are circumferentially arranged around the hub body **138**' adjacent to the brake rotor attachment portion **138***d*'. Preferably, the first spoke openings **160***a*' are spaced axially inward of the brake rotor attachment portion **138***d*' so that brake disc rotor **132**' can be easily attached with the bolts **132***a*' and nuts **132***b*'.

In this embodiment, the spoke openings **160***a*' and **160***b*' are arranged to form two circumferential rows of spoke openings **160***a*' at end section **138***a*' and two circumferential rows of spoke openings **160***b*' at end section **138***b* '. Each of the spoke openings **160***a*' and **160***b*' has an insertion portion **161**' and a retaining portion **162**'. Adjacent pairs of the spoke openings **160***a*' and **160***b*' are oriented in opposite directions so that the spokes **24** extend in generally opposite directions from the hub body **138**'.

Each insertion portion **161**' is formed by a curved or partial cylindrical surface **164**' that has a width or diameter that is equal to or slightly larger than the widths or diameters of the enlarged heads **24***c* of the spokes **24**. Thus, the inner ends (bent ends **24***b* with enlarged heads **24***c*) of the spokes **24** can be easily inserted into the spoke openings **160***a*' and **160***b*' through the insertion portions **161**'.

The retaining portions **162**' have smaller widths or diameters than the insertion portions **161**'. More specifically, the diameters or widths of the retaining portions **162**' are smaller than the diameters or widths of the enlarged heads **24***c* of the spokes **24** so as to retain the spokes **24** within the spoke openings **160***a*' and **160***b*'. The retaining portions **162**' are each preferably defined by a partial cylindrical surface **166**' that is connected to the curved surface **164**' of the associated insertion portion **161**'.

Preferably, the insertion portion **161**' and the retaining portions **162**' of each spoke opening are formed simultaneously. Also preferably, the inner and outer ends of the retaining portions **162**' of the spoke openings **160***a*' and **160***b*' are tapered to avoid sharp edges engaging the spokes **24**.

Similar to the first embodiment, discussed above, each of the insertion portions **161**' has a center longitudinal axis that passes through the center axis A' of the hub axle **136**'. The retaining portions **162**', on the other hand, have center longitudinal axes that are parallel to the center longitudinal axis of the associated insertion portion **161**' for each of the spoke openings **160***a*' and **160***b*'. Thus, the center longitudinal axes of the retaining portions **162**' do not pass through the center axis of the hub axle **136**', similar to the first embodiment. Rather, the center longitudinal axes of the retaining portions **162**' are angled with respect to center axis A'. Preferably, the center longitudinal axis of each retaining portion **162**' is angled between about 5° and about 20° from a radial orientation in the hub body **138**'. In the illustrated embodiment, the retaining portions **162**' are angled about 10° with respect to center axis A' for a twenty-six inch rim with thirty-six spoke holes and a hub having a diameter approximately 22 millimeters. For a twenty-six inch rim with thirty-two spoke holes and a hub having a diameter approximately 22 millimeters, the retaining portions **162**' are preferably angled about 11° with respect to center axis A'. This angled configuration of the retaining portions **162**' results in the straight sections **24***a* of the spokes **24** being easily arranged in a tangential direction relative to an imaginary circle centered on the hub body **138**'. Moreover, this angled configuration of the retaining portions **162**' allows the straight sections **24***a* of the spokes **24** to be easily aligned with the spoke holes of the rim without significant bending of the spokes **24**. In the illustrated embodiment, the spokes **24** are not bent more than about five degrees.

Third Embodiment of Front Hub

Referring now to FIG. **30**, a front bicycle hub **222** is illustrated in accordance with a third embodiment of the present invention. The front hub **222** of this third embodiment is substantially the same as the front hub **22**' shown in FIG. **16**, except that the left half of the front hub **222** has been modified to be substantially a mirror image of the right half of the front hub **222**. In other words, the front hub **222** is not designed to have a disc rotor coupled thereto. Since the front hub **222** is substantially the same as the front hub **22**' of the first embodiment, this third embodiment will not be discussed or illustrated in detail herein.

The front hub **222** basically includes a hub axle **236**, a hub body or shell **238**, a first bearing assembly **240***a*, a second bearing assembly **240***b*, a first spoke seal **242***a*, a second spoke seal **242***b* and a quick release mechanism **246**. Of the parts of front hub **222**, only the hub body **238** and the first and second spoke seals **242***a* and **242***b* are non-conventional parts. The remaining parts of front hub **222** are relatively conventional, and thus, the remaining parts of front hub **222** will not be discussed or illustrated in detail herein.

The hub axle **236** has a center axis A extending between a first end **236***a* and a second end **236***b*. The quick release mechanism **246** extends through a center bore **236***c* of the hub axle **236** such that the quick release mechanism **246** is coupled to the hub axle **236** in a conventional manner. The first and second ends **236***a* and **236***b* of the hub axle **236** are threaded for receiving a pair of nuts **250***a* and **250***b* that apply an axial force on the hub body **238**, the bearing assemblies **240***a* and **240***b* and the spoke seals **242***a* and **242***b*. First and second bearing assemblies **240***a* and **240***b* rotatably mount the hub body **238** on the hub axle **236**.

The hub body **238** is illustrated in accordance with one embodiment of the present invention. In this embodiment, the hub body **238** is a hollow member that defines an interior passageway **252** with the hub axle **236** being rotatably supported therein by the first and second bearing assemblies **240***a* and **240***b*. Thus, the hub body **238** is a substantially tubular member. Specifically, the hub body **238** has a center tubular portion **238***c* with first and second end sections **238***a* and **238***b* being integral formed with the center tubular portion **238***c* as a one-piece, unitary member.

A set of first spoke openings **260***a* are provided at the first end section **238***a* of the hub body **238** for receiving the bent

ends of the spokes **224**. Similarly, the second end section **238***b* of the hub body **238** is provided with a second set of spoke openings **260***b* for receiving the bent ends of the spokes **224**. In the illustrated embodiment, the first end section **238***a* is provided with nine of the first spoke openings **260***a* and the second end section **238***b* is provided with nine of the second spoke openings **260***b*. The spoke openings **260***a* and **260***b* are equally spaced apart about the circumference of the hub body **238**. Each of the spoke openings **260***a* and **260***b* are also designed to receive two spokes **224** as explained below. Accordingly, the front hub **222** is designed to have thirty-six spokes extending outwardly therefrom in a generally tangential direction.

Preferably, the first and second sets of spoke openings **260***a* and **260***b* are identical, expect that the first and second sets of spoke openings **260***a* and **260***b* are circumferential offset, i.e., not axially aligned. The first and second spoke openings **260***a* and **260***b* are designed to be used with tangential spokes **224**. Of course, it is possible that the first and second sets of spoke openings **260***a* and **260***b* can be different such that tangential spokes **224** are used in one end of the hub body **238** and a different types of spokes are used in the other end of the hub body **238**.

In this embodiment, the first and second spoke openings **260***a* and **260***b* are elongated slots that are each provided with an insertion portion **261** and a pair of retaining portions **262**. Accordingly, each of the spoke openings **260***a* and **260***b* is designed to have a pair of spokes **224** retained therein with the spokes **224** extending in opposite directions. The first and second spoke openings **260***a* and **260***b* have the identical shapes as the spoke openings **60***a* as seen in FIGS. **9–11**.

Bearing assemblies **240***a* and **240***b* rotatably supports hub body **238** on hub axle **236**. In this embodiment, bearing assemblies **240***a* and **240***b* are identical to each other, except that they are mirror images of each other. The bearing assembly **240***a* basically includes a plurality of balls **274***a* located between an inner race member **276***a* and an outer race member **278***a*. Similarly, the bearing assembly **240***b* basically includes a plurality of balls **274***b* located between an inner race member **276***b* and an outer race member **278***b*. Since bearing assemblies **240***a* and **240***b* are well known in the bicycle art, they will not be discussed or illustrated in detail herein.

However, the arrangement of the bearing assemblies **240***a* and **240***b* relative to the first and second spoke openings **260***a* and **260***b* is unique in that the bearing assemblies **240***a* and **240***b* are located at least partially beneath the first and second spoke openings **260***a* and **260***b*. This arrangement provides for better rigidity of the wheel and the hub axle **236**. Specifically, the outer circumferential rows of the retaining portions **262** of the first and second spoke openings **260***a* and **260***b* have their centers lying on radial planes P_1 and P_2, respectively. As seen in FIG. **30**, the planes P_1 and P_2 intersect at least part of the bearing assemblies **240***a* and **240***b*, respectively. Plane P_1 passes through the balls **274***a*, the inner race member **276***a* and the outer race member **278***a*. Similarly, the plane P_2 passes through the balls **274***b*, the inner race member **276***b* and the outer race member **280***b*.

The spoke seals **242***a* and **242***b* are arranged in the interior passageway **252** of the hub body **238** so as to be adjacent the spoke openings **260***a* and **260***b* to isolate the spoke openings **260***a* and **260***b* from the hub axle **236**. In other words, the spoke seals **242***a* and **242***b* prevent contaminants from entering the front hub **222** through the spoke openings **260***a* and **260***b*. The spoke seals **242***a* and **242***b* are preferably resilient members that are constructed of rubber or the like. Of course, it will be apparent to those skilled in the art from this disclosure that the seals could be created from other types of materials, depending upon their shape and arrangement.

In the preferred embodiment, the spoke seals **242***a* and **242***b* also aid in the assembly of the spokes **224** with the hub body **238** and the rim. Specifically, in the preferred embodiments, the seals **242***a* and **242***b* are arranged so that they restrain movement of the spokes **224** within the spoke openings **260***a* and **260***b* so that the bent ends of the spokes **224** stays in the retaining portions **262** of the spoke openings **260***a* and **260***b*. The seals **242***a* and **242***b* are identical in construction to the seal **42***b'* as seen in FIG. **18**.

Third Embodiment of Rear Hub

Referring now to FIG. **31**, a rear bicycle hub **322** is illustrated in accordance with a third embodiment of the present invention. The rear hub **322** of this third embodiment includes many of the same features of the rear hub **22** as seen in FIG. **5**. Therefore, the common features between the rear hub **22** and the rear hub **322** will not be discussed herein when describing the rear hub **322**.

The rear hub **322** basically includes a hub axle **336**, a hub body or shell **338** (two parts), a first bearing assembly **340***a*, a second bearing assembly **340***b*, a first spoke seal **342***a*, a second spoke seal **342***b*, a freewheel **344** and a quick release mechanism **346**. Of the parts of rear hub **322**, only the hub body **338** and the first and second spoke seals **342***a* and **342***b* are non-conventional parts. The remaining parts of rear hub **322** are relatively conventional, and thus, the remaining parts of rear hub **322** will not be discussed or illustrated in detail herein.

The hub axle **336** has a center axis A extending between a first end **336***a* and a second end **336***b*. The quick release mechanism **346** extends through a center bore **336***c* of the hub axle **336** such that the quick release mechanism **346** is coupled to the hub axle **336** in a conventional manner. The first and second ends **336***a* and **336***b* of the hub axle **336** are threaded for receiving a pair of nuts **350***a* and **350***b* that apply an axial force on the hub body **338**, the bearing assemblies **340***a* and **340***b*, the spoke seals **342***a* and **342***b*, and the freewheel **344**. First and second bearing assemblies **340***a* and **340***b* rotatably mount the hub body **338** with the freewheel **344** on the hub axle **336**. The freewheel **344** allows the hub axle **336** to rotate freely relative to the hub body **338** in one direction, but fixedly couples the hub axle **336** relative to the hub body **338** in the opposite rotational direction.

The hub body **338** of this embodiment of the present invention is constructed of two pieces. In this embodiment, the hub body **338** is a hollow member that defines an interior passageway **352** with the hub axle **336** being rotatably supported therein by the first and second bearing assemblies **340***a* and **340***b*. Thus, the hub body **338** is a substantially tubular member. Specifically, the hub body **338** has a center tubular portion **338***c* with first and second end sections **338***a* and **338***b*.

The first end section **338***a* is integrally formed with the center tubular portion **338***c* and the inner ring portion **388***b* as a one-piece, unitary member. The second end section **338***b* of the hub body **338** is constructed of two pieces (outer member or portion **339** and inner ring member or portion **388***b*). The second end section **338***b* has the freewheel **344** fixedly coupled thereto. Preferably, the outer portion **339** has internal threads that engage external threads of the inner ring

portion **388***b* to fixedly couple them together and to prevent relative rotation therebetween. The outer portion **339** is held on the inner ring portion **388***b* by the axial force applied to the various parts of the hub **322** by nuts **350***a* and **350***b*. This type of arrangement reduces the manufacturing costs of the hub shell or body **338**.

A set of first spoke openings **360***a* are provided at the first end section **338***a* of the hub body **338** for receiving the bent ends of the spokes **324**. Similarly, the second end section **338***b* of the hub body **338** is provided with a second set of spoke openings **360***b* for receiving the bent ends of the spokes **324**. In the illustrated embodiment, the first end section **338***a* is provided with nine of the first spoke openings **360***a* and the second end section **338***b* is provided with nine of the second spoke openings **360***b*. The spoke openings **360***a* and **360***b* are equally spaced apart about the circumference of the hub body **338**. Each of the spoke openings **360***a* and **360***b* are also designed to receive two spokes **324** as explained below. Accordingly, the rear hub **322** is designed to have thirty-six spokes extending outwardly therefrom in a generally tangential direction.

Preferably, the first and second sets of spoke openings **360***a* and **360***b* are identical, expect that the first and second sets of spoke openings **360***a* and **360***b* are circumferential offset, i.e., not axially aligned. The first and second spoke openings **360***a* and **360***b* are designed to be used with tangential spokes **324**.

In this embodiment, the first and second spoke openings **360***a* and **360***b* are elongated slots that are each provided with an insertion portion **361** and a pair of retaining portions **362**. Accordingly, each of the spoke openings **360***a* and **360***b* is designed to have a pair of spokes **324** retained therein with the spokes **324** extending in opposite directions. The first and second spoke openings **360***a* and **360***b* have the identical shapes as the spoke openings **60***a* as seen in FIGS. **9–10**.

Bearing assemblies **340***a* and **340***b* rotatably supports hub body **338** on hub axle **336**. The bearing assembly **340***a* basically includes a plurality of balls **374***a* located between an inner race member **376***a* and an outer race member **378***a*. Similarly, the bearing assembly **340***b* basically includes a plurality of balls **374***b* located between an inner race member **376***b* and an outer race member **378***b*. Since bearing assemblies **340***a* and **340***b* are well known in the bicycle art, they will not be discussed or illustrated in detail herein.

The spoke seals **342***a* and **342***b* are arranged in the interior passageway **352** of the hub body **338** so as to be adjacent the spoke openings **360***a* and **360***b* to isolate the spoke openings **360***a* and **360***b* from the hub axle **336**. In other words, the spoke seals **342***a* and **342***b* prevent contaminants from entering the rear hub **322** through the spoke openings **360***a* and **360***b*. The spoke seals **342***a* and **342***b* are preferably resilient members that are constructed of rubber or the like. Of course, it will be apparent to those skilled in the art from this disclosure that the seals could be created from other types of materials, depending upon their shape and arrangement.

In the preferred embodiment, the spoke seals **342***a* and **342***b* also aid in the assembly of the spokes **324** with the hub body **338** and the rim. Specifically, in the preferred embodiments, the seals **342***a* and **342***b* are arranged so that they restrain movement of the spokes **324** within the spoke openings **360***a* and **360***b* so that the bent ends of the spokes **324** stay in the retaining portions **362** of the spoke openings **360***a* and **360***b*.

In this embodiment, the ring-shaped member **388***a* and the inner ring member or portion **388***b* support the spoke seals **342***a* and **342***b* from moving inwardly in a radial direction. More specifically, these members are constructed of rigid material and have an annular ring-shape that prevents the radial inward movement of the spoke seals **342***a* and **342***b*. The particular shape of the ring members **388***a* and **388***b* depend upon the adjacent structures of the hub. Accordingly, their specific shapes will not be discussed or illustrated in detail herein.

In the illustrated embodiment, the spoke seal **342***a* has a tubular section and a center annular flange. The center annular flange of the spoke seal **342***a* extends in a circumferential direction about the tubular section. The center annular flange can either contact the interior surface of the hub body **338** or be spaced from the hub body **338**. The particular shape of the ends of the spoke seal **342***a* will vary depending on the shape of the hub body **338** and its internal parts.

When the rear hub **322** is assembled, an axial force is applied to the ends of the tubular section of the spoke seal **342***a* to form annular seals therebetween. Thus, the spoke seal **342***a* isolates a first interior section of the interior passageway **352** from the remainder of the interior passageway **352**. This interior section formed by the spoke seal **342***a* is continuous annular first space located beneath the spoke openings **360***a*. Basically, the construction of the spoke seal **342***a* is substantially identical in construction to the seal **32***a*' as seen in FIG. **17**, except that the center flange has been made wider and the inner end of the seal **342***a* has a slightly different shape. However, the spoke seal **342***a* performs the same function as the seal **42***a*', discussed above. In particular, the spoke seal **342***a* is positioned to axially separate the two retaining portions **362** of each of the first spoke openings **360***a* from each. The center annular flange of spoke seal **342***a* is also positioned to keep the spokes **324** in the retaining portions **362** of the first spoke openings **360***a*.

Similar to the spoke seal **342***a*, the spoke seal **342***b* has a tubular section and a center annular flange. The center annular flange of the spoke seal **342***b* extends in a circumferential direction about the tubular section. The ends of the tubular section of the spoke seal **342***b* are configured to engage a ring member **388***b* and an abutment **390***b* of the inner surface of the hub body **338**. Of course, the particular shape of the ends of the spoke seal **342***b* will vary depending on the shape of the hub body **338** and its internal components.

When the rear hub **322** is assembled, an axial force is applied to the ends of the tubular section of the spoke seal **342***b* to form annular seals therebetween. Accordingly, the spoke seal **342***b* isolates a second interior section of the interior passageway **352** from the remainder of the interior passageway **352**. This interior section formed by the spoke seal **342***b* is a continuous annular second space located beneath the spoke openings **360***b*.

The center annular flange of the spoke seal **342***b* is preferably aligned with a radial plane passing through the centers axes of the insertion portions **361** of the second spoke openings **360***b*. Thus, the center annular flange of the spoke seal **342***b* is positioned to axially separate the two retaining portions **362** of each of the second spoke openings **360***b* from each other. The center annular flange of the spoke seal **342***b* is also positioned to keep spokes **324** in the retaining portions **362** of the second spoke openings **360***b*. Accordingly, when the enlarged heads of the spokes **324** are inserted into the insertion portions **361** of the spoke openings **360***b*, the enlarged heads of the spokes **324** contact the

center annular flange of the spoke seal **342***b*. The enlarged heads then push or deform the center annular flange of the spoke seal **342***b* one way or the other so that the enlarged heads extend into the insertion portions **361** of the spoke openings **360***b*. The spokes **324** are then moved or slid into one of the two retaining portions **362** of each of the spoke openings **360***b*. The center annular flange of the spoke seal **342***b* will prevent the spokes **324** from accidentally falling out of the insertion portions **361** of the spoke openings **360***b*. In other words, the center annular flange of the spoke seal **342***b* must be moved or deformed again before the spokes **324** can be removed from the spoke openings **360***b*.

The freewheels, such as the freewheel **344**, are well known in the bicycle art, and thus, the freewheel **344** will not be illustrated or discussed in detail herein. The freewheel **344** is used to transmit a driving force from the chain to the rear bicycle wheel in one rotation direction only. The freewheel **344** allows the bicycle to advance freely without any rotation of the pedals. The freewheel **344** is fastened to the rear hub **322** as integral part of the rear hub **322** in a conventional manner. The freewheel **344** has an outer tubular part **394**, an inner tubular part **396** and a one-way clutch **398**. The inner tubular part **396** is installed radially inwardly of the outer tubular part **394** so that the inner tubular part **396** is free to rotate relative to the outer tubular part **394**. The one-way clutch **398** is installed between the outer tubular part **394** and inner tubular part **396** for transmitting the driving force from the outer tubular part **394** to the inner tubular part **396** in one rotational direction only. The outer tubular part **394** has a plurality of gears or sprockets (not shown) mounted thereon, while the inner tubular part **396** is usually mounted on the hub axle **336**.

Fourth Embodiment of Rear Hub

Referring now to FIGS. **32–36**, a rear bicycle hub **422** is illustrated in accordance with a third embodiment of the present invention. The rear hub **422** of this third embodiment includes many of the same features of the rear hub **22** as seen in FIG. **5**. Therefore, the common features between the rear hub **22** and the rear hub **422** will not be discussed herein when describing the rear hub **422**.

The rear hub **422** basically includes a hub axle **436**, a hub body or shell **438**, a first bearing assembly **440***a*, a second bearing assembly **440***b*, a first spoke seal **442***a* with a seal support **443***a*, a second spoke seal **442***b*, a freewheel **444** and a quick release mechanism **446**. Of the parts of rear hub **422**, only the hub body **438** and the first and second spoke seals **442***a* and **442***b* are non-conventional parts. The remaining parts of rear hub **422** are relatively conventional, and thus, the remaining parts of rear hub **422** will not be discussed or illustrated in detail herein.

The hub axle **436** has a center axis A extending between a first end **436***a* and a second end **436***b*. The quick release mechanism **446** extends through a center bore **436***c* of the hub axle **436** such that the quick release mechanism **446** is coupled to the hub axle **436** in a conventional manner. The first and second ends **436***a* and **436***b* of the hub axle **436** are threaded for receiving a pair of nuts **450***a* and **450***b* that applies an axial force on the hub body **438**, the bearing assemblies **440***a* and **440***b*, the spoke seals **442***a* and **442***b*, and the freewheel **444**. First and second bearing assemblies **440***a* and **440***b* rotatably mount the hub body **438** with the freewheel **444** on the hub axle **436**. The freewheel **444** allows the hub axle **436** to rotate freely relative to the hub body **438** in one direction, but fixedly couples the hub axle **436** relative to the hub body **438** in the opposite rotational direction.

The hub body **438** is illustrated in accordance with one embodiment of the present invention. In this embodiment, the hub body **438** is a hollow member that defines an interior passageway **452** with the hub axle **436** being rotatably supported therein by the first and second bearing assemblies **440***a* and **440***b*. Thus, the hub body **438** is a substantially tubular member. Specifically, the hub body **438** has a center tubular portion **438***c* with first and second end sections **438***a* and **438***b* being integral formed with the center tubular portion **438***c* as a one-piece, unitary member. The first end section **438***a* has an integrally mounted brake rotor attachment portion **438***d*, while a second end section **438***b* has the freewheel **444** fixedly coupled thereto. Each of the end sections **438***a* and **438***b* has an annular groove **439***c* and **439***b*, respectively, for receiving spoke opening covers **100'** or **100"** or **500** as explained below.

A set of first spoke openings **460***a* are provided at the first end section **438***a* of the hub body **438** for receiving the bent ends **424***b* of the spokes **424**. Similarly, the second end section **438***b* of the hub body **438** is provided with a second set of spoke openings **460***b* for receiving the bent ends **424***b* of the spokes **424**. In the illustrated embodiment, the first end section **438***a* is provided with nine of the first spoke openings **460***a* and the second end section **438***b* is provided with nine of the second spoke openings **460***b*. The spoke openings **460***a* and **460***b* are equally spaced apart about the circumference of the hub body **438**. Each of the spoke openings **460***a* and **460***b* are also designed to receive two spokes **424** as explained below. Accordingly, the rear hub **422** is designed to have thirty-six spokes extending outwardly therefrom in a generally tangential direction.

Preferably, the first and second sets of spoke openings **460***a* and **460***b* are identical. The first and second spoke openings **460***a* and **460***b* are designed to be used with conventional tangential spokes **424**. Of course, it is possible that the first and second sets of spoke openings **460***a* and **460***b* can be different such that tangential spokes **424** are used in one end of the hub body **438** and a different types of spokes are used in the other end of the hub body **438**. The first spoke openings **460***a* are circumferentially arranged around the hub body **438** adjacent to the brake rotor attachment portion **438***d*. Preferably, the first spoke openings **460***a* are spaced axially inward of the brake rotor attachment portion **438***d* so that a brake disc rotor can be easily attached thereto via the bolts and nuts in the same manner as illustrated in FIG. **5**.

In this embodiment, the first and second spoke openings **460***a* and **460***b* are elongated slots that are each provided with an insertion portion **461** and a pair of retaining portions **462**. Accordingly, each of the spoke openings **460***a* and **460***b* is designed to have a pair of spokes **424** retained therein with the spokes **424** extending in opposite directions.

The insertion portion **461** of each spoke opening is located between the pair of retaining portions **462** of each spoke opening. Each insertion portion **461** is formed by a pair of opposed curved surfaces that are spaced apart so as to be equal to or slightly larger than the widths or diameters of the enlarged heads of the spokes **424**. Thus, the inner ends (bent ends **424***b* with enlarged heads) of the spokes **424** can be easily inserted into the spoke openings **460***a* and **460***b* through the insertion portions **461**.

The brake rotor attachment portion **438***d* is integrally formed with the center tubular portion **438***c* of the hub body **438** as a one-piece, unitary member. In the illustrated embodiment, the brake rotor attachment portion **438***d* is formed with six attachment members or points with through

bores **470**. While six individual attachment points are preferred, it will be apparent to those skilled in the art from this disclosure that fewer or more attachment points can be utilized. Moreover, it will be apparent to those skilled in the art from this disclosure that the attachment portions could be a continuous flange, if needed and/or desired. The through bore **470** can be threaded or unthreaded. By using through bores **470** instead of blind bores, the rear hub **422** can be easily manufactured at a relatively lower cost.

Bearing assemblies **440***a* and **440***b* rotatably supports hub body **438** on hub axle **436**. The bearing assembly **440***a* basically includes a plurality of balls **474***a* located between an inner race member **476***a* and an outer race member **478***a*. Similarly, the bearing assembly **440***b* basically includes a plurality of balls **474***b* located between an inner race member **476***b* and an outer race member **478***b*. Since bearing assemblies **440***a* and **440***b* are well known in the bicycle art, they will not be discussed or illustrated in detail herein.

The spoke seals **442***a* and **442***b* are arranged in the interior passageway **452** of the hub body **438** so as to be adjacent the spoke openings **460***a* and **460***b* to isolate the spoke openings **460***a* and **460***b* from the hub axle **436**. In other words, the spoke seals **442***a* and **442***b* prevent contaminants from entering the rear hub **422** through the spoke openings **460***a* and **460***b*. The spoke seals **442***a* and **442***b* are preferably resilient members that are constructed of rubber or the like. Of course, it will be apparent to those skilled in the art from this disclosure that the seals could be created from other types of materials, depending upon their shape and arrangement. Moreover, it will be apparent to those skilled in the art from this disclosure that while the spoke seals **442***a* and **442***b* are illustrated as a pair of separate sealing members, the spoke seals **442***a* and **442***b* can be formed as a one-piece, unitary member.

In the preferred embodiment, the spoke seals **442***a* and **442***b* also aid in the assembly of the spokes **424** with the hub body **438** and the rim. Specifically, in the preferred embodiments, the seals **442***a* and **442***b* are arranged so that they restrain movement of the spokes **424** within the spoke openings **460***a* and **460***b* so that the bent ends **424***b* of the spokes **424** stays in the retaining portions **462** of the spoke openings **460***a* and **460***b*. As best seen in FIG. **34**, a left sealing assembly is formed of the spoke seal **442***a* and seal support **443***a*. The seal support **443***a* is constructed of a hard rigid plastic material that prevents the spoke seal **442***a* from being deflected radially inwardly into the interior of the hub. In other words, the seal support **443***a* maintains the spoke seal **442***a* in a sealing position.

In the illustrated embodiment, the spoke seal **442***a* has a tubular section **480***a* and a center annular flange **482***a*. The center annular flange **482***a* extends in a circumferential direction about the tubular section **480***a*. The center annular flange **482***a* can either contact the interior surface of the hub body **438** or be spaced slightly from the hub body **438**. The ends **484***a* and **486***a* of the tubular section **480***a* are configured to engage a ring member **488***a* and an abutment **490***a* of the inner surface of the hub body **438**. Of course, the particular shape of the ends **484***a* and **486***a* will vary depending on the shape of the hub body **438** and its internal components. Preferably, ends **484***a* and **486***a* of the tubular section **480***a* are annular flanges that contact the interior surface of the hub body **438** to form an isolated area beneath the spoke openings **460***a*. This isolated area beneath the spoke openings **460***a* is a continuous annular space.

When the rear hub **422** is assembled, an axial force is applied to the ends **484***a* and **486***a* of the tubular section **480***a* to form annular seals therebetween. Accordingly, the spoke seal **442***a* isolates a first interior section of the interior passageway **452** from the remainder of the interior passageway **452**. This interior section formed by the spoke seal **442***a* is continuous annular first space located beneath the spoke openings **460***a*.

The center annular flange **482***a* is preferably aligned with a radial plane passing through the centers axes of the insertion portions **461** of the first spoke openings **460***a*. Thus, the center annular flange **482***a* is positioned to axially separate the two retaining portions **462** of each of the first spoke openings **460***a* from each other. The center annular flange **482***a* is also positioned to keep spokes **424** in the retaining portions **462** of the first spoke openings **460***a*. Accordingly, when the enlarged heads **424***c* of the spokes **424** are inserted into the insertion portions **461** of the spoke openings **460***a*, the enlarged heads **424***c* of the spokes **424** contact the center annular flange **482***a*. The enlarged heads **424***c* then push or deform the center annular flange **482***a* one way or the other so that the enlarged heads **424***c* extends into the insertion portions **461** of the spoke openings **460***a*. The spokes **424** are then moved or slid into one of the two retaining portions **462** of each of the spoke openings **460***a*. The center annular flange **482***a* will prevent the spokes **424** from accidentally falling out of the insertion portions **461** of the spoke openings **460***a*. Thus, the center annular flange **482***a* aids in the assembly of the rear wheel. In other words, the center annular flange **482***a* must be moved or deformed again before the spokes **424** can be removed from the spoke openings **460***a*.

The seal support **443***a*, as seen in FIGS. **33** and **34**, is a substantially tubular member constructed of a relatively hard rigid material, such as a hard plastic material. The configuration of seal support **443***a* should basically compliment the interior surface of the spoke seal **442***a*. In other words, the seal support **443***a* is located within the interior bore of the spoke seal **442***a* so as to provide radial support to spoke seal **442***a*. In the illustrated embodiment, the seal support **443***a* has a first tubular portion **470***a*, an annular flange **472***a* and a second annular or cylindrical portion **474***a*. When the seal support **443***a* is located within seal **442***a*, the exterior surfaces of the cylindrical portions **470***a* and **474***a* contact the step-shaped inner surface of the tubular section **480***a*.

Similar to the spoke seal **442***a*, the spoke seal **442***b* has a tubular section **480***b* and a center annular flange **482***b*. The center annular flange **482***a* extends in a circumferential direction about the tubular section **480***a*. Alternatively, the center annular flanges **482***a* and **482***b* of the spoke seals **442***a* and **442***b* can each have a pair of center annular flanges. The end **484***b* of the tubular section **480***b* is configured to engage a ring member **488***b* and an abutment **490***b* of the inner surface of the hub body **438**. The end **486***b* of the tubular section **480***b* is configured to be engaged to the ring member **488***b* and a part of the freewheel **444**. Of course, the particular shape of the ends **484***b* and **486***b* will vary depending on the shape of the hub body **438** and its internal components. Preferably, the end **486***b* of the tubular section **480***b* has an inwardly extending annular flange that contacts the outer surface of the ring member **488***b*.

When the rear hub **422** is assembled, an axial force is applied to the ends **484***b* and **486***b* of the tubular section **480***b* to form annular seals therebetween. Accordingly, the spoke seal **442***b* isolates a second interior section of the interior passageway **452** from the remainder of the interior passageway **452**. This interior section formed by the spoke seal **442***b* is continuous annular second space located beneath the spoke openings **460***b*.

Similar to the center annular flange **482***a*, the center annular flange **482***b* is preferably aligned with a radial plane passing through the centers axes of the insertion portions **461** of the second spoke openings **460***b*. Thus, the center annular flange **482***b* is positioned to axially separate the two retaining portions **462** of each of the second spoke openings **460***b* from each other. The center annular flange **482***b* is also positioned to keep spokes **424** in the retaining portions **462** of the second spoke openings **460***b*. Accordingly, when the enlarged heads **424***c* of the spokes **424** are inserted into the insertion portions **461** of the spoke openings **460***b*, the enlarged heads **424***c* of the spokes **424** contact the center annular flange **482***b*. The enlarged heads **424***c* then pushes or deforms the center annular flange **482***b* one way or the other so that the enlarged heads **424***c* extends into the insertion portions **461** of the spoke openings **460***b*. The spokes **424** are then moved or slid into one of the two retaining portions **462** of each of the spoke openings **460***b*. The center annular flange **482***b* will prevent the spokes **424** from accidentally falling out of the insertion portions **461** of the spoke openings **460***b*. Thus, the center annular flange **482***b* aids in the assembly of the rear wheel. In other words, the center annular flange **482***b* must be moved or deformed again before the spokes **424** can be removed from the spoke openings **460***b*.

The ring-shaped member **488***b* is non-rotatably coupled to the hub body **438**. The ring member **488***b* has the freewheels **444** rotatably mounted thereon. The ring member **488***b* also provides radial support for the spoke seal **442***b*.

The freewheels, such as the freewheel **444**, are well known in the bicycle art, and thus, the freewheel **444** will not be illustrated or discussed in detail herein. The freewheel **444** is used to transmit a driving force from the chain to the rear bicycle wheel in one rotation direction only. The freewheel **444** allows the bicycle to advance freely without any rotation of the pedals. The freewheel **444** is fastened to the rear hub **422** as integral part of the rear hub **422** in a conventional manner. The freewheel **444** has an outer tubular part **494**, an inner tubular part **496** and a one-way clutch **498**. The inner tubular part **496** is installed radially inwardly of the outer tubular part **494** so that the inner tubular part **496** is free to rotate relative to the outer tubular part **494**. The one-way clutch **498** is installed between the outer tubular part **494** and inner tubular part **496** for transmitting the driving force from the outer tubular part **494** to the inner tubular part **496** in one rotational direction only. The outer tubular part **494** has a plurality of gears or sprockets (not shown) mounted thereon, while the inner tubular part **496** is usually mounted on the hub axle **436**.

As seen in FIGS. **35** and **36**, a spoke opening cover **500** in accordance with another embodiment of the present invention is illustrated for use with the rear hub **422** of FIGS. **32** and **33**. Of course, the spoke opening cover **500** can be used with other hubs disclosed herein. Although for purposes of brevity, the spoke opening cover **500** will only be illustrated with the rear hub **422**.

The spoke opening cover **500** is used to limit or prevent contaminants from entering the hub body **438** via the spoke openings **460***a* or **460***b*, respectively. The spoke opening cover **500** can be used instead of the spoke seals **442***a* and **442***b* or in conjunction with the spoke seals **442***a* and **442***b*. The spoke opening cover **500** basically has a resilient tubular body **501** constructed from a flexible material such as rubber. The tubular body **501** of the spoke opening covers **500** are configured and dimensioned to snugly fit around the bicycle hub body **438** within the annular grooves **439***a* and **439***b* and to be substantially flush with the outer surface of the hub body **438** as seen in FIG. **32**. The spoke opening cover **500** is installed on each end of the hub body **438** prior to installation of spokes **424**. Of course, the annular grooves **439***c* and **439***b* can receive other types of spoke opening covers. For example, spoke opening covers **100'** or **100"** can be positioned within the annular grooves **439***a* and **439***b* so that the outer surfaces of the spoke opening covers **100'** or **100"** are flush with the outer surface of the hub body **438**.

While only selected embodiments have been chosen to illustrate the present invention, it will be apparent to those skilled in the art from this disclosure that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims. Furthermore, the foregoing description of the embodiments according to the present invention are provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

What is claimed is:

1. A bicycle hub for use with bicycle spokes, said bicycle hub comprising:

a hub axle having a center axis extending between a first end and a second end;

a hub body having an interior passageway with said hub axle being rotatably supported therein, a set of first spoke openings circumferentially arranged around said hub body;

a first flexible seal arranged in said interior passageway of said hub body and adjacent said first spoke openings to isolate said first spoke openings from said hub axle; and

a first rigid seal support located beneath said first flexible seal to radially support said first flexible seal.

2. A bicycle hub according to claim **1**, wherein

said first flexible seal is an annular member with an inner surface.

3. A bicycle hub according to claim **2**, wherein

said first rigid seal support is an annular member with an outer surface that is configured to mate with said inner surface of said first flexible seal.

4. A bicycle hub according to claim **2**, wherein

said first flexible seal is positioned between said hub axle and said hub body to isolate a first interior section of said interior passageway adjacent said first spoke openings.

5. A bicycle hub according to claim **4**, wherein

said first interior section of said interior passageway is a continuous annular first space.

6. A bicycle hub according to claim **5**, wherein

each of said first spoke openings has an insertion portion with a large width that permits an enlarged head portion of a spoke to pass therethrough and a first retaining portion with a width that is smaller than said width of said insertion portion to retain the enlarged head portion of the spoke therein.

7. A bicycle hub according to claim **6**, wherein

said first flexible seal includes a first tubular section with at least one first flange extending radially outward from said first tubular section in a plane intersecting said insertion portions of said first spoke openings.

8. A bicycle hub according to claim **6**, wherein

said first flexible seal includes a first tubular section with a portion that is positioned to keep spokes in said first retaining portions of said first spoke openings.

9. A bicycle hub according to claim 6, wherein

each of said first spoke openings includes a second retaining portion to retain the enlarged head portions of two spokes with in each of said first spoke openings.

10. A bicycle hub according to claim 9, wherein

said first flexible seal includes a first tubular section with at least one first flange extending radially outward from said first tubular section in a plane intersecting said insertion portions of said first spoke openings.

11. A bicycle hub according to claim 9, wherein

said first flexible seal includes a first tubular section with a portion that is positioned to keep spokes in said first and second retaining portions of said first spoke openings.

12. A bicycle hub according to claim 1, further comprising

a freewheel coupled to said second end of said axle to rotate relative to said hub body.

13. A bicycle hub according to claim 1, wherein

said hub body has an outer surface with a first annular groove, each of said first spoke openings has an insertion portion located along said first annular groove and a first retaining portion, said insertion portion having a large width that permits an enlarged head portion of a spoke to pass therethrough, and said first retaining portion having a width that is smaller than said width of said insertion portion to retain the enlarged head portion of the spoke therein.

14. A bicycle hub according to claim 13, further comprising

a first spoke opening cover located with in said first annular groove.

15. A bicycle hub according to claim 14, wherein

said first spoke opening cover has an outer surface that is flush with said outer surface of said hub body.

16. A bicycle hub according to claim 13, wherein

said hub body further includes a second annular groove said outer surface and a set of second spoke openings circumferentially arranged around said hub body at a location that is axially spaced from said first spoke openings, each of said second spoke openings has an insertion portion located along said second annular groove and a first retaining portion, said insertion portions of said second spoke openings having large widths that permit enlarged head portions of spokes to pass therethrough, and said first retaining portions of said second spoke openings having a width that is smaller than said width of said insertion portion of second spoke openings to retain the enlarged head portions of the spokes therein.

17. A bicycle hub according to claim 16, further comprising

a first spoke opening cover located with in said first annular groove, and a second spoke opening cover located with in said second annular groove.

18. A bicycle hub according to claim 17, wherein

said first and second spoke opening covers have outer surfaces that are flush with said outer surface of said hub body.

19. A bicycle hub for use with bicycle spokes, said bicycle hub comprising:

a hub axle having a center axis extending between a first end and a second end; and

a hub body having an outer surface with a first annular groove, an interior passageway with said hub axle being rotatably supported therein, a set of first spoke openings circumferentially arranged around said hub body, each of said first spoke openings has an insertion portion located along said first annular groove and a retaining portion, said insertion portion having a large width that permits an enlarged head portion of a spoke to pass therethrough, and said retaining portion having a width that is smaller than said width of said insertion portion to retain the enlarged head portion of the spoke therein.

20. A bicycle hub according to claim 19, further comprising

a first spoke opening cover located with in said first annular groove.

21. A bicycle hub according to claim 20, wherein

said first spoke opening cover has an outer surface that is flush with said outer surface of said hub body.

22. A bicycle hub according to claim 19, wherein

said hub body further includes a second annular groove said outer surface and a set of second spoke openings circumferentially arranged around said hub body at a location that is axially spaced from said first spoke openings, each of said second spoke openings has an insertion portion located along said second annular groove and a first retaining portion, said insertion portions of said second spoke openings having large widths that permit enlarged head portions of spokes to pass therethrough, and said first retaining portions of said second spoke openings having a width that is smaller than said width of said insertion portion of second spoke openings to retain the enlarged head portions of the spokes therein.

23. A bicycle hub according to claim 22, further comprising

a first spoke opening cover located with in said first annular groove, and a second spoke opening cover located with in said second annular groove.

24. A bicycle hub according to claim 23, wherein

said first and second spoke opening covers have outer surfaces that are flush with said outer surface of said hub body.

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